Curriculum Framework

Bachelor of Science in Physics

As per NEP 2020 and Learning Outcomes-based National Curriculum Framework
(Aligned with NCrF and NHEQF)

Effective From Academic Year 2025-2026

Founded by Mahatma Gandhi in 1920

Gujarat Vidyapith
Ahmedabad

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Bachelor of Science
(Physics)

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(Updated on 26-12-2025)

GUJARAT VIDYAPITH: AHMEDABAD

Curriculum Framework of Bachelor of Science (Physics)

Published by:

Dr. Himanshu Patel

Registrar

Gujarat Vidyapith

Near Income Tax Office, Ashram Road, Ahmedabad - 380009.

From the Desk of Vice Chancellor…

Dear All,

Any curriculum, at any level, must be firmly grounded in the objectives and goals that an educator or an educational institution aspires to achieve for its students. A course that trains students to solve mathematical equations must be very different from one that teaches them how to play a musical instrument, practice yoga, or conduct social research. Each subject requires its own methods, activities, and learning goals, which is why curriculum design is so important.

Therefore, curriculum is of utmost importance, as it determines how teachers and students will spend their time—in laboratories, in clinical practice, in creative endeavors, or in interactive lectures. It also reflects what a class, a department, a school, or an institution values; what it defines as its mission; and what it expects its graduates to accomplish. In this sense, the curriculum is the map that guides the essentials of learning from the classroom level to the institutional level.

The true success of any curriculum must be judged by its ability to achieve its intended objectives. It is a test of how well an institution—or an individual teacher—understands and articulates those objectives, and how effectively a pathway is created for students to attain success as defined by them. Curriculum is, in fact, a continuous chain of activities designed to translate broad educational goals into concrete practices, learning materials, and observable changes in behavior. A lesson plan, for instance, is curriculum at the classroom level, answering the critical questions: *What do I want my students to know? How can I engage them meaningfully? How will I measure what they have learned?*

For a society to achieve its educational aspirations, the curriculum must be both functional and relevant to its needs. Through careful management of curriculum, effective use of resources, and policies that bring systemic improvements, education can move society toward a more promising future. Indeed, curriculum is the very foundation of any academic institution—without it, the institution would lose its purpose and direction.

At Gujarat Vidyapith, established by Mahatma Gandhi in 1920 with its rich cultural and educational heritage, we remain committed to these ideals and we work with well-defined objectives to prepare our students for a brighter academic and social future.

It gives me immense pride and joy to announce the unveiling of the latest curriculum of Gujarat Vidyapith. This curriculum has been carefully designed in alignment with the objectives and guiding principles of the National Education Policy (NEP) 2020. I take this opportunity to place on record my deep appreciation for the efforts of the teaching faculty of Gujarat Vidyapith, the Members of the Board of Studies, and the Members of the Academic Council. Their dedication and vision have given shape to this comprehensive neo-curriculum, which will guide our students and our institution toward continued excellence.

With best wishes,

Dr. Harshad Patel
Vice Chancellor
Gujarat Vidyapith

Curriculum Framework

Bachelor of Science
(Physics)

Effective From Academic Year 2025-2026

(Updated on 26-12-2025)

Department of Physics

Faculty of Science

Gujarat Vidyapith

Board of Studies

Chairperson:

Dr. Nikhil S. Bhatt
Professor & Dean, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

External Experts:

1) **Dr. Shailesh R. Dave**
   Professor & Director, Xavier's Research Foundation, Ahmedabad.

2) **Dr. Rakesh Patel**
   Retired Faculty, R.G. Shah Science college, Physics Department, Ahmedabad.

Members from the Department:

1) **Dr. Mayur C. Shah**
   Professor & Head, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

2) **Dr. Srinivas Duggirala**
   Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

3) **Dr. Niraj T. Sheth**
   Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

4) **Dr. Prateek G. Shilpkar**
   Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

5) **Mrs. Preeti K. Shukla**
   Associate Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

6) **Dr. Kaushik R. Patel**
   Associate Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

7) **Mr. Arvind B. Dungrechiya**
   Assistant Professor, Department of Physics, Faculty of Science, Gujarat Vidyapith, Ahmedabad.

PROGRAMME STRUCTURE							
Course Code	Course Name	Hours			Credit	Evaluations	
		Theory	Practical	Total		CCE	TEE
SEMESTER-1							
254510336001	Optics	45	0	45	3	40	60
254510236002	Physics Practical	0	60	60	2	40	60
254510337001	Physical Chemistry	45	0	45	3	40	60
254510237002	Physical Chemistry Practical	0	60	60	2	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**195**	**210**	**405**	**20**	**280**	**420**
SEMESTER-2							
254510336003	Waves and Electronics	45	0	45	3	40	60
254510236004	Physics Practical	0	60	60	2	40	60
254510337003	Inorganic Chemistry	45	0	45	3	40	60
254510237004	Inorganic Chemistry Practical	0	60	60	2	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**195**	**210**	**405**	**20**	**280**	**420**
SEMESTER-3							
255010336005	Solid State, Classical and Nuclear Physics	45	0	45	3	40	60
255010336006	Physics Practical	0	90	90	3	40	60
255010337005	Organic Chemistry	45	0	45	3	40	60
255010337006	Organic Chemistry Practical	0	90	90	3	40	60
-	Multidisciplinary Course (MDC) **Annexure-1**	45	0	45	3	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Skill Enhancement Course (SEC) **Annexure-4**	0	90	90	3	40	60
Total		**165**	**270**	**435**	**20**	**280**	**420**
SEMESTER-4							
255010336007	Thermodynamics, Magnetostatics and Modern Physics	45	0	45	3	40	60
255010336008	Basic Electronics	45	0	45	3	40	60
255010236009	Physics Practical	0	60	60	2	40	60
255010337007	Organic Chemistry	45	0	45	3	40	60
255010337008	Analytical Chemistry	45	0	45	3	40	60
255010237009	Organic and Analytical Chemistry Practical	0	60	60	2	40	60
-	Ability Enhancement Course (AEC) **Annexure-2**	30	0	30	2	40	60
-	Value added Course (VAC) **Annexure-3**	30	0	30	2	40	60
Total		**240**	**120**	**360**	**20**	**320**	**480**

EMESTER-5							
255510336010	Electronics	45	0	45	3	40	60
255510336011	Quantum Mechanics	45	0	45	3	40	60
255510336012	Classical Mechanics	45	0	45	3	40	60
255510536013	Physics Practical	0	150	150	5	40	60
255510436014	Internship	0	120	120	4	40	60
255510236015	Biosensors (Discipline Specific Elective)	30	0	30	2	40	60
255510236016	Instrumentation (Discipline Specific Elective)						
255510236017	Statistics (Discipline Specific Elective)						
Total		**165**	**270**	**435**	**20**	**240**	**360**
SEMESTER-6							
255510336018	Nuclear Physics	45	0	45	3	40	60
255510236019	Physics Practical	0	60	60	2	40	60
255510336020	Electronics	45	0	45	3	40	60
255510236021	Physics Practical	0	60	60	2	40	60
255510336022	Mathematical Physics	45	0	45	3	40	60
255510236023	Physics Practical	0	60	60	2	40	60
255510336024	Solid State Physics	45	0	45	3	40	60
255510236025	Physics Practical	0	60	60	2	40	60
Total		**180**	**240**	**420**	**20**	**320**	**480**
GRAND TOTAL		**1140**	**1320**	**2460**	**120**	**1720**	**2580**

***CCE- Continuous Comprehensive Evaluation; **TEE- Term End Evaluation**

Program Summary								
Broad Category of Course	**Sem-1**	**Sem-2**	**Sem-3**	**Sem-4**	**Sem-5**	**Sem-6**	**Total**	**Required**
Major (Core)	3+2= **05**	3+2= **05**	3+3= **06**	6+2= **08**	9+5= **14**	12+8= **20**	**60**	**60**
DSE (Discipline Specific Elective)	-	-	-	-	**2**	-		
Minor	3+2= **05**	3+2= **05**	3+3= **06**	6+2= **08**	-	-	**24**	**24**
Multidisciplinary	**03**	**03**	**03**	-	-	-	**09**	**09**
Ability Enhancement course	**02**	**02**	**02**	**02**	-	-	**08**	**08**
Skill Enhancement Course	**03**	**03**	**03**	-	-	-	**09**	**09**
Value added Courses	**02**	**02**	-	**02**	-	-	**06**	**06-08**
Internship	-	-	-	-	**04**		**04**	**02-04**
Total	**20**	**20**	**20**	**20**	**20**	**20**	**120**	**120**

Eligibility criteria: Bachelor of Science (B.Sc.)

Sr. No	Course	Required Qualifications
1	B.Sc. Physics	12th Pass with PCM/ PCB

Major and Minor subject

Sr. No	Major	Minor
1	Physics	Chemistry: G-1 /Mathematics: G-2

Programme Outcomes (POs)

This program prepares graduates to achieve the following POs within three years of graduation.

PO-1	**Discipline-Specific Knowledge**	The program develops a strong foundation in scientific principles through interdisciplinary learning, enabling students to apply Natural Sciences and Mathematics to real-world problems. It builds core competencies that prepare graduates for higher education and professional careers.
PO-2	**Problem Analysis**	Graduates develop critical thinking and analytical skills by integrating knowledge from Natural Sciences and Mathematics. They apply scientific methodologies and quantitative techniques to independently solve complex issues.
PO-3	**Experimental Skills**	Students gain hands-on experience in designing, conducting, and analyzing experiments using modern scientific tools. This fosters accuracy, reproducibility, and practical application across various domains.
PO-4	**Environment and Sustainability**	The curriculum promotes ecological awareness and sustainable practices. By linking Natural Sciences with global environmental issues, students develop a scientific approach to sustainability and social responsibility.
PO-5	**Ethics and Values**	Graduates uphold Gandhian values, professional ethics, and integrity. The program fosters responsible application of scientific knowledge within ethical frameworks, encouraging social accountability.
PO-6	**Communication**	Students acquire strong oral and written communication skills, enabling them to articulate scientific concepts, write technical reports, and engage in interdisciplinary dialogue effectively.
PO-7	**Modern Tool Usage**	The program familiarizes students with advanced scientific instruments, IT tools, and analytical software. Graduates can ethically and effectively apply these tools across research and industry sectors.
PO-8	**Teamwork and Leadership**	Graduates are prepared to contribute meaningfully to multidisciplinary teams, demonstrating leadership and collaboration in diverse scientific and professional environments.
PO-9	**Lifelong Learning**	The program instills motivation for lifelong learning and adaptability. Students are equipped to independently explore and incorporate new knowledge and skills in a rapidly changing world.
PO-10	**Project Management**	Graduates develop organizational and economic skills essential for managing scientific research projects and investigations. The curriculum emphasizes planning, execution, and evaluation of scientific work.
PO-11	**Innovation and Entrepreneurship**	The program fosters creative thinking, problem-solving, and entrepreneurial mindset. Students are encouraged to develop innovative scientific solutions with societal impact.
PO-12	**Societal Contribution**	Graduates understand the role of science in society and apply their knowledge for the public good. Emphasis is placed on rural

		development, informed public discourse, and Gandhian ideals of service and self-reliance.

Programme Specific Outcomes (PSOs)

After successful completion of "Three Year Degree Program" in Physics, a student will be able to:

PSO Number	Programme Specific Outcomes (PSOs)	Justification
PSO-1	Graduates will possess a deep and comprehensive understanding of fundamental concepts and theories across classical mechanics, electromagnetism, thermodynamics, quantum mechanics, and optics, and be able to analytically apply this knowledge to model, analyze, and solve complex physical problems.	Supports: PO1 (Discipline-Specific Knowledge) by building a strong physics foundation; PO2 (Problem Analysis) through analytical problem-solving; PO9 (Lifelong Learning) by providing a conceptual base for new knowledge; and PO11 (Innovation and Entrepreneurship) by enabling innovative solutions via fundamental principles.
PSO-2	Graduates will be proficient in designing and safely conducting physics experiments, utilizing modern scientific instruments and computational tools for data acquisition, analysis, and interpretation, thereby drawing valid and reproducible scientific conclusions.	Grounded in: PO3 (Experimental Skills) by focusing on experiment design and analysis; PO7 (Modern Tool Usage) through instrument and software application; PO2 (Problem Analysis) by interpreting experimental data; PO10 (Project Management) by covering investigation planning and execution; and PO6 (Communication) as a precursor to reporting findings.
PSO-3	Graduates will effectively communicate scientific ideas, experimental methodologies, and research findings through professional reports and presentations, engage in collaborative scientific endeavours, and uphold ethical standards in all scientific practices and societal contributions.	Aligns with: PO6 (Communication) by emphasizing scientific articulation and reporting; PO8 (Teamwork and Leadership) through collaborative endeavors; PO5 (Ethics and Values) by upholding professional integrity; PO12 (Societal Contribution) by linking ethical practice to public good; and PO10 (Project Management) as communication and collaboration are key to project success.

CO Attainment Levels (OBE & NEP 2020 Aligned)

COs Attainment Levels	**Level**	**Description**	**Attainment Criteria**			
	Level 3	High	≥ 60% students scored ≥ Benchmark			
	Level 2	Moderate	50–59% students scored ≥ Benchmark			
	Level 1	Low	40–49% students scored ≥ Benchmark			
	Level 0	Not Attained	< 40% students scored ≥ Benchmark			
Target Attainment (Benchmark)	**COs**			**CO-1**	**CO-2**	**CO-3**	**CO-4**
	Target Level (%)			**55**	**55**	**55**	**55**

Program – B.Sc. (Physics) Semester- 1		
Course Code **254510336001**	**Name of Course** **Optics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Demonstrate understanding of key optical phenomena such as reflection, refraction, interference, and diffraction.
CO-2:	Explain the fundamental principles of LASER and the techniques used for its generation.
CO-3:	Explain the basic principles and applications of holography and fiber optics.

Detailed Syllabus

Unit-1. Optics (15h)

1.1 Diffraction of Light

1.1.1 Introduction
1.1.2 Difference between Interference and Diffraction
1.1.3 Fresnel and Fraunhofer Types of diffraction
1.1.4 Diffraction pattern due to narrow slit

1.2 Resolving Power of Optical Instrument

1.2.1 Resolving power
1.2.2 Limit of resolution of eye
1.2.3 Resolving power of optical instruments
1.2.4 Rayleigh's criterion of resolution
1.2.5 Resolving power of a telescope
1.2.6 Relation between magnifying power and resolving power of telescope
1.2.7 Resolving power of a prism
1.2.8 Resolving power of a plane transmission grating

Unit-2. Laser (15h)

2.1 Interaction of light with matter Absorption

2.1.1 Absorption
2.1.2 Spontaneous emission
2.1.3 Stimulated emission

2.2 Meeting the three requirements

2.2.1 Population inversion
2.2.2 Metastable states
2.2.3 Confining radiation within the medium

2.3 Components of LASER

2.3.1 Active medium
2.3.2 Pumping
2.3.3 Optical resonant cavity

2.4 Lasing Action

2.5 Principal pumping schemes

2.5.1 Three-level pumping scheme
2.5.2 Four-level pumping scheme

2.6 Types of LASERS

2.6.1 Ruby Laser
2.6.2 Helium-Neon Laser
2.6.3 Carbon Dioxide Laser
2.6.4 Semiconductor Laser (PN-Junction Laser)

2.7 Characteristics of LASER

2.8 Applications

Unit-3. Holography and Fiber Optics (15h)

3.1. Holography

3.1.1 Basic principle of holography
3.1.2 Recording of holography
3.1.3 Reconstruction of image from holography
3.1.4 Applications of holography

3.2 FIBER OPTICS

3.2.1 Principle of Fiber optics
3.2.2 Structure and classification of optical fiber
3.2.3 The Numerical Aperture (NA)
3.2.4 Fiber optics communication system
3.2.5 Advantage of optical fiber communication system
3.2.6 Applications

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	**3**	**2**	**1**	**1**	**-**	**1**	**2**	**2**	**3**	**-**	**2**	**1**	**1.80**	3	1	1	1.67
CO-2	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2.22**	3	1	1	1.67
CO-3	**3**	**2**	**-**	**3**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**1**	**2.29**	3	1	1	1.67
Avg	**3**	**2.3**	**1.0**	**2**	**-**	**1.7**	**2**	**2**	**3**	**2**	**1.5**	**1.33**	**2.1**	**3**	**1**	**1**	**1.67**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	• Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	• Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	• Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- A Textbook of Optics, N. Subrahmanyam, Brij Lal, S. Chand Publishing, 2024
- Optics, Ajoy Ghatak, Tata McGraw Hill, 2023
- Engineering Physics, R. K. Gaur, S. L. Gupta, Dhanpat Rai Publications, 2023
- Optics and Atomic Physics, D. P. Khandelwal, Himalaya Publishing House, 2022
- Fiber Optics and Optoelectronics, R. P. Khare, Oxford University Press, 2022
- An Introduction to Lasers: Theory and Applications, M. N. Avadhanulu, S. Chand Publishing, 2023

Online Resources & Tools:

- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 1

Course Code 254510236002	Name of Course PHYSICS PRACTICAL	Major
Credit: 02	Teaching Scheme: Practical (60)	Teaching Hours: 60

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of matter, electricity, magnetism, and optics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. To determine the resolving power of prism.
2. To determine Cauchy's constant A and B using a given formula and graph.
3. To determine the resolving power of Plan Diffraction Grating.
4. To determine the wavelength of sodium light using plane diffraction grating.
5. To determine the resolving power of plane diffraction grating.
6. Find out the refractive index of different liquids using convex lenses.
7. LASER characteristics
8. Wireless communication using Fiber optic

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	1	**2.00**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	3	2	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	3	2	2	**2.33**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.22**	**3**	**2**	**1**	**2.00**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	• Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	• Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	• Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 2		
Course Code **254510336003**	**Name of Course** **Waves and Electronics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Explain the basic properties, generation, and applications of X-rays as a form of electromagnetic radiation.
CO-2:	Demonstrate foundational knowledge of sound wave generation, propagation, and properties.
CO-3:	Acquire essential knowledge of basic electronic circuit elements and their applications.

Detailed Syllabus

Unit-1. X-RAYS (15h)

- **1.1 Discovery of X-rays**
- **1.2 Properties of X-rays**
- **1.3 Production of X-rays**
- **1.4 Origin of X-rays**
- **1.5 Detectors of X-rays**
  - **1.5.1** Gieger Muller counter
  - **1.5.2** Proportional counter
  - **1.5.3** Scintillation counter
- **1.6 Diffraction of X-rays**
  - **1.6.1** Bragg's law
  - **1.6.2** Crystallography by powder diffraction method
  - **1.6.3** Crystal rotating method
- **1.7 Applications of X-rays**

Unit-2. Sound (15h)

- **2.1 Travelling waves**
  - **2.1.1** Speed of propagation of waves in a stretched string
  - **2.1.2** Longitudinal waves in a bar
  - **2.1.3** Plane waves in fluid
  - **2.1.4** Transmission of energy by a travelling wave
- **2.2 Sound wave:**
  - **2.2.1** Introduction, Intensity & its level,
  - **2.2.2** Loudness & pitch
  - **2.2.3** Radiation efficiency of a sound source
  - **2.2.4** Newton's formula and Laplace's correction
- **2.3 Ultrasonic:**
  - **2.3.1** Introduction,
  - **2.3.2** Piezoelectric effect
  - **2.3.3** Piezoelectric oscillator
  - **2.3.4** Magnetostriction method
  - **2.3.5** characteristics of ultrasonic waves
  - **2.3.6** velocity of sound in liquid
  - **2.3.7** Applications of ultrasonic waves

Unit-3. Electronics and Circuits (15h)

- **3.1 Energy level in solids,**
  - **3.1.1** Valance band,
  - **3.1.2** Conduction band and forbidden band
  - **3.1.3** Conductor semiconductor and insulator

3.1.4 Chemical bonds in semiconductor like germanium and silicon
3.1.5 Pure or intrinsic semiconductor
3.1.6 Impurity or extrinsic semiconductor
3.1.7 The p-n junction
3.1.8 The unbiased diode
3.1.9 Forward and Reverse biased diodes – its characteristics

3.2 Rectifying Circuits

3.2.1 Half wave rectifier
3.2.2 Voltage regulation
3.2.3 Ripple factor
3.2.4 Full wave rectifier
3.2.5 Bridge rectifier
3.2.6 Filter Circuits
3.2.6.1 The inductor filter
3.2.6.2 The capacitor filter
3.2.6.3 L-C filter
3.2.6.4 π filter
3.2.6.5 Comparisons of filter circuits

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	2	-	-	-	-	-	2	1	2	2	**2.00**	3	-	-	3
CO-2	3	-	1	2	2	3	-	2	-	2	-	-	**2.14**	3	-	-	3
CO-3	3	-	2	-	2	-	2	3	-	-	-	2	**2.33**	3	-	-	3
Avg	**3**	**2.0**	**1.6**	**2**	**2**	**3**	**2**	**2.5**	**2**	**1.5**	**2**	**2**	**2.16**	3	-	-	3

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Engineering Physics, R. K. Gaur, S. L. Gupta, Dhanpat Rai Publications, 2023
- Mechanics, Wave Motion and Heat, F. W. Sears, Addison-Wesley, 2020

- A Textbook of Oscillations, Waves and Acoustics, M. Ghosh, D. Bhattacharya, S. Chand Publishing, 2022
- Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw Hill, 2023
- Electronic Devices and Circuits: An Introduction, Allen Mottershead, Prentice-Hall India, 2022
- **Online Resources & Tools**:
  SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics)
Semester- 2

Course Code	Name of Course	Major
254510236004	PHYSICS PRACTICAL	
Credit: 02	Teaching Scheme: Practical (60)	Teaching Hours: 60

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of matter, electricity, magnetism, and optics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. To study half wave rectifier with and without filter.
2. To study full wave rectifier with and without filter.
3. To study bridge rectifier with and without filter.
4. To study the characteristics of Zener diode and use as voltage regulator.
5. To verify Stefan Boltzman's fourth power law using an AC source.
6. Determination of Miller Indices
7. Find out light velocity by ultrasonic waves
8. Capacitance measurements
9. Inductance measurements

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	2.22	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics record book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 3		
Course Code **255010336005**	**Name of Course** **Solid State, Classical and Nuclear Physics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1	Demonstrate understanding of fundamental concepts in solid state physics, including crystal structure and electronic properties of solids.
CO-2	Apply basic principles of classical mechanics to analyze the motion of particles and rigid bodies under various force conditions.
CO-3	Explain the core concepts of nuclear physics, including nuclear structure, stability, and types of nuclear reactions.

Detailed Syllabus

Unit-1. Solid State Physics (15h)

1.1 Crystal Structure

- **1.1.1** Periodic Arrays of Atoms
- **1.1.2** Lattice translation vectors
- **1.1.3** Basis, Lattice, Lattice primitive cell, Wigner-Seitz unit cell
- **1.1.4** Fundamental Types of Lattice
- **1.1.5** Two -dimensional lattice types, Oblique lattice, Bravice lattice
- **1.1.6** Three-dimensional lattice types
- **1.1.7** Index system(indices) for crystal planes
- **1.1.8** Simple Crystal Structures
- **1.1.9** Sodium Chloride structure
- **1.1.10** Calcium chloride structure
- **1.1.11** Hexagonal closed packed structure (hcp)
- **1.1.12** Diamond structure

Unit-2. Classical Mechanics (15h)

2.1 Central Force

- **2.1.1** Equivalent one-body problem
- **2.1.2** Motioning Central Force field
- **2.1.3** General Features of the Motion
- **2.1.4** Motion in an inverse-square law force field

2.2 Oscillations and Collisions

- **2.2.1** Simple Harmonic Oscillator
- **2.2.2** Damped Harmonic Oscillator
- **2.2.3** Elastic and Inelastic Scattering
- **2.2.4** Laboratory and Centre of Mass Systems
- **2.2.5** Kinematics of Elastic Scattering in Lab System

Unit-3. Nuclear Physics (15h)

3.1 Detector for Nuclear Particles

- **3.1.1** Geiger Counter
- **3.1.2** Proportional Counter
- **3.1.3** Scintillation Counter
- **3.1.4** Solid state or semiconductor detector
- **3.1.5** Compton suppressed germanium detector

3.2 Cloud and bubble chambers

3.3 Particle Accelerators

- **3.3.1** Van de Graff generator

3.3.2 The cyclotron
3.3.3 The Synchrotron
3.3.4 The Betatron
3.3.5 Beta Ray Spectrometer

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	-	3	2	3	-	2	-	1	-	2	**2.25**	3	2	1	**2.00**
CO-2	3	1	2	-	-	-	2	2	3	2	-	-	**2.14**	3	2	2	**2.33**
CO-3	3	-	1	-	-	-	2	-	-	3	2	-	**2.20**	3	1	2	**2.00**
Avg	3	1.5	1.5	3.	2	3	2	2	3	2	2	2	**2.2**	**3**	**2**	**1**	**2.00**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Elements of Solid-state Physics, J. P. Srivastava, PHI Learning, 2023
- Classical Mechanics, R. G. Takwale, P. S. Puranik, Tata McGraw Hill, 2023
- Introduction to Solid State Physics, Charles Kittel, Wiley, 2024
- Nuclear Physics: An Introduction, S. B. Patel, New Age International, 2023
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 3

Course Code 255010336006	Name of Course PHYSICS PRACTICAL	Major
Credit: 03	Teaching Scheme: Practical (90)	Teaching Hours: 90

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of matter, electricity, magnetism, and optics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Miller Index
2. GM counter
3. Crystal system
4. Relaxation time using simple pendulum
5. Analysis of Error
6. Nuclear Decay
7. XRD Spectra analysis

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	2.17	3	2	2	2.33
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	2.25	2	3	2	2.33
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	2.25	2	3	3	2.67
Avg	2.33	2.33	3.00	2.00	2.00	2.33	2.67	2.00	2.00	2.00	2.00	2.00	2.22	2.33	2.67	2.33	2.44

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References
• **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 4		
Course Code **255010336007**	**Name of Course** **Thermodynamics, Magnetostatics and Modern Physics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Demonstrate a fundamental understanding of heat and thermodynamic processes, including laws of thermodynamics and their applications.
CO-2:	Explain the key concepts of magnetostatics and analyze magnetic field behavior in various physical systems.
CO-3:	Describe the foundational principles of modern physics, including quantum theory and relativity, and their significance in contemporary scientific advancements.

Detailed Syllabus

Unit-1. Heat & Thermodynamics (15h)

1.1 Introduction: Thermodynamic laws (only definition)
1.2 Carnot Theorem
1.3 Principle & working of Refrigerator,
- 1.3.1 Phase diagram,
- 1.3.2 triple point,
- 1.3.3 Kelvin temperature scale

1.4 Clausius- Clapeyron's Equation

1.5 Entropy
- 1.5.1 Reversible part of the second law (Clausius theorem)
- 1.5.2 Entropy
- 1.5.3 Entropy of ideal gas
- 1.5.4 T – S diagram
- 1.5.5 Application of the entropy principle

Unit-2. Magnetostatics (15h)

2.1 Steady Current and Magnetostatics
- 2.1.1 Electric Current
- 2.1.2 Ohm's Law - Electrical conductivity
- 2.1.3 Magnetic Effects
- 2.1.4 The Magnetic Field
- 2.1.5 Force on a current
- 2.1.6 Bio-Savart law
- 2.1.7 The Laws of Magnetostatics
- 2.1.8 The Magnetic potential

2.2 Magnetic Media
2.3 Magnetization
2.4 Magnetic Field Vector
2.5 **Magnetic Susceptibility and Permeability**

Unit-3. Modern Physics (15h)

3.1 Special Theory of Relativity
- 3.1.1 Postulates of special relativity. (with Michelson Morley experiment)
- 3.1.2 Time dilation
- 3.1.3 Doppler effect
- 3.1.4 Length contraction

3.2 Relativity of mass
3.3 Mass and energy
3.4 Lorentz transformation
3.5 Velocity addition

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	-	-	2	1	2	-	2	-	3	-	-	**2.2**	3	2	2	2.33
CO-2	3	2	-	-	-	-	-	-	-	-	-	1	**2**	3	1	2	2.00
CO-3	3	-	1	-	2	-	-	-	-	2	-	3	**2.2**	3	1	2	2.00
Avg	**3**	**2**	**1**	**2**	**1.5**	**2**	**-**	**2**	**-**	**2.5**	**-**	**2**	**2.1**	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Heat and Thermodynamics, Mark W. Zemansky, Richard H. Dittman, McGraw Hill, 2023
- Electromagnetics, B. B. Laud, New Age International, 2023
- Modern Physics, Kenneth Krane, Wiley, 2021
- **Online Resources & Tools**:
- SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics) Semester- 4		
Course Code **255010336008**	**Name of Course** **Basic Electronics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Understand semiconductor devices and analog circuits.
CO-2:	Apply op-amps and digital logic principles.
CO-3:	Design basic digital systems and sequential circuits.

Detailed Syllabus

Unit-1 Introduction of Semiconductor

1.1 Introduction to Circuit Elements, review of circuit laws, and network theorems
1.2 Semiconductor diodes- types, biasing and applications.
1.3 Bipolar Transistor-symbols, configurations and characteristics
1.4 Biasing Techniques of BJT, Construction of small signal Amplifier

Unit-2 OPAMPS and digital electronics

2.1 Introduction to OPAMPS, Characteristic features and Mathematical operations and Applications
2.2 Number Systems, Digital codes and inter conversions
2.3 Logic Gates and Boolean Algebra
2.4 Presentation and Simplification of combinational Logic expressions, Karnaugh-maps

Unit-3 Digital Electronics

3.1 Adders, Multiplexers and multiplexer, encoders and decoders
3.2 Construction and evaluation of flip flops, time-out diagrams
3.3 Construction of Digital Counters and applications
3.4 Construction of shift registers and applications

Mapping Matrix of POs, PSOs, and COs																	
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	1	–	–	–	1	–	1	–	–	–	1.60	3	1	–	2.33
CO-2	3	3	2	–	–	1	2	–	1	–	1	–	1.86	2	3	1	2
CO-3	2	3	3	–	–	2	2	1	2	1	2	–	2.00	2	3	2	2
Avg	2.67	2.67	2.00	-	-	1.50	1.67	1.00	1.33	1.00	1.50	-	1.70	3.00	1.33	2.00	2.11

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Principles of Electronic Devices and Circuits, B.L. Thereja and R.S. Sedha, S. Chand Publications, ISBN 9788121921992
- Schaum's Outline of Electronic Devices and Circuits, Jimmie Cathey, 2nd Edn, McGraw Hill Publishers 9780071362702
- Basic Electronics for Scientists and Engineers, Dennis L Eggleston, Cambridge University Press, ISBN 9781107696785
- Digital fundamentals, Thomas L. Floyd, Pearson Publications, 9789332584600
- Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, Pearson Publications, 978-9332549913
- Schaum's Outline of Digital Principles, Roger L. Tokheim, 3rd Edn, McGraw Hill Publishers, 978-0070650503
- **Online Resources & Tools**:
  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 4

Course Code 255010236009	Name of Course PHYSICS PRACTICAL	Major
Credit: 02	Teaching Scheme: Practical (60)	Teaching Hours: 60

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of electronics and digital electronics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. PN junction diode characteristics (with temperature)
2. Effect of temperature on semiconductor
3. Thermocouple
4. Thermistor
5. Binary addition and subtraction
6. Hall effect measurement
7. Analog to digital converter
8. Digital to Analog converter
9. Characteristics of Tunnel Diode

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.22**	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

	COs	Marks	Exam Component
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
	COs	**Marks**	**Exam Component**

Term-End Evaluation 60 Marks	**CO-1**	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510336010**	**Name of Course** **Electronics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Explain the fundamental principles of amplifiers and their role in signal processing applications.
CO-2:	Analyse the frequency response of amplifiers and interpret its effect on signal amplification and bandwidth.
CO-3:	Understand and apply basic concepts of digital electronics, including logic gates and digital circuit design

Detailed Syllabus

Unit-1. Amplifier Characteristics (15h)

1.1 General amplifier characteristics (Distortion)

- **1.1.1** Introduction, concept of amplification
- **1.1.2** Amplifier notations
- **1.1.3** Current gain, voltage gain, power gain
- **1.1.4** Amplifier input & output resistance
- **1.1.5** Maximum power transfer
- **1.1.6** Conversion efficiency
- **1.1.7** Classes of amplifier operation
- **1.1.8** Harmonic distortion
- **1.1.9** Three-point method of calculating harmonic distortion
- **1.1.10** Five-point method of calculating harmonic distortion
- **1.1.11** Oscilloscope display of an amplifier dynamic transfer curve
- **1.1.12** Measurement of harmonic distortion, other types of amplifier distortion

1.2 General amplifier characteristics (Decibels)

- **1.2.1** Introduction,
- **1.2.2** Decibels, other equations for decibel computation,
- **1.2.3** zero dB reference level,
- **1.2.4** use of voltmeter as dB indicator,
- **1.2.5** voltmeter range correction factor,
- **1.2.6** impedance correction factor
- **1.2.7** frequency response curves
- **1.2.8** amplifier bandwidth
- **1.2.9** phase relationship in amplifier square wave testing.

Unit-2. Frequency Response of a Transistor Amplifier (15h)

2.1 Low frequency response of a transistor amplifier:

- **2.1.1** Introduction
- **2.1.2** Effect of an emitter bypass capacitor on low frequency response
- **2.1.3** Effect of coupling capacitor on low frequency response
- **2.1.4** Cascading of CE stages, mid frequency gains
- **2.1.5** Low frequency response of cascaded stages
- **2.1.6** Amplifier low frequency response to a square wave
- **2.1.7** Transformer coupled transistor amplifier
- **2.1.8** Low frequency response of TC amplifier, step response of a TC amplifier

2.2 High frequency response of a transistor amplifier:

- **2.2.1** Introduction
- **2.2.2** High frequency model for a CE amplifier
- **2.2.3** Approximate CE high frequency model with a resistive load

2.2.4 CE short circuit current gain
2.2.5 High frequency current gain with a resistive load
2.2.6 High frequency response of cascaded CE stages
2.2.7 Amplifier high frequency response to a square wave
2.2.8 High frequency response of a transformer coupled amplifier
2.2.9 Principal pumping schemes

Unit-3. DIGITAL ELECTRONICS (15h)

3.1 Circuit analysis & design

3.1.1 Boolean laws and theorems, sum of products method
3.1.2 Truth table to Karnaugh map, pairs
3.1.3 Quads and octets,
3.1.4 Karnaugh simplification, don't care conditions
3.1.5 Product of sums method product of sums simplification.

3.2 Arithmetic circuits:

3.2.1 Binary addition binary subtraction
3.2.2 Unsigned binary number
3.2.3 Sign magnitude numbers,
3.2.4 2' S compliment representation,
3.2.5 2'S compliment arithmetic building blocks.

3.3 FLIP- FLOP

3.3.1 RS flip flop
3.3.2 Clocked RS flip flop
3.3.3 D flip flop,
3.3.4 Edged triggered D flip flop
3.3.5 JK flip flop, JK master slave flip flop

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	1	-	2	-	-	-	2	-	-	2	3	**2.17**	3	2	2	2.33
CO-2	3	-	2	-	-	-	1	-	3	-	1	-	**2**	3	1	2	2.00
CO-3	3	3	1	-	-	-	2	1	-	-	-	3	**2.17**	3	1	2	2.00
Avg	**3**	**2**	**1.5**	**2**	**-**	**-**	**1.5**	**1.5**	**3**	**-**	**1.5**	**3**	**2.11**	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	• Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	• Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	• Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References
• Digital Principles and Applications, Albert Paul Malvino, Donald P. Leach, McGraw Hill, 2023 • Electronic Devices and Circuits: An Introduction, Allen Mottershead, Prentice-Hall India, 2022 • **Online Resources & Tools**: SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510336011**	**Name of Course** **Quantum Mechanics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Solve exactly solvable eigenvalue problems in quantum mechanics and interpret their physical significance.
CO-2:	Explain the concepts of eigenvalues, eigenfunctions, and binding energy in the context of quantum systems.
CO-3:	Demonstrate an understanding of representations, transformations, and symmetries and their role in the formulation of quantum mechanics.

Detailed Syllabus

Unit-1. Exactly Soluble Eigen Value Problems (15h)

- **1.1** Introduction
- **1.2** The simple harmonic oscillator
- **1.3** The Schrödinger equation and energy eigen values
- **1.4** The energy eigen functions
- **1.5** Properties of stationary states
- **1.6** The abstract operator method,
- **1.7** Coherent states, the angular momentum operators,
- **1.8** The eigen value equation for L2, separation of variables
- **1.9** Admissibility conditions on solutions,
- **1.10** Eigen values,
- **1.11** The eigen functions
- **1.12** Spherical harmonics,
- **1.13** Physical interpretation,
- **1.14** Parity
- **1.15** Angular momentum in stationary states of systems with spherical symmetry

Unit-2. Three-Dimensional Square Well Potential (15h)

- **2.1** Solutions in interior region
- **2.2** Solutions in the exterior Region and Matching
- **2.3** Theory of Hydrogen atom: Solution of the radial Equation
- **2.4** Energy levels
- **2.5** Stationary state wave functions
- **2.6** Discussion of bound states
- **2.7** Other problems
- **2.8** In three dimensions: The anisotropic oscillator,
- **2.9** The isotropic oscillator, normal modes of coupled systems of particles.

Unit-3. Representations, Transformations and Symmetries (15h)

- **3.1** **Quantum states,**
  - 3.1.1 State vectors and wave function
  - 3.1.2 The Hilbert space of state vectors
  - 3.1.3 Dirac
- **3.2** **Notation,**
- **3.3** **Dynamical variables and linear operators, Representations**
- **3.4** **Continuous basis – The Schrödinger representation, Degeneracy**
- **3.5** **Labelling by commuting observable**
- **3.6** **Change of basis, Unitary transformations**
- **3.7** **Unitary transformation induced by change of coordinate system:**

	3.7.1	translation, Unitary transformation induced by Rotation of coordinate system,
	3.7.2	The algebra of Rotation generators,
	3.7.3	Transformation of dynamical variables,
	3.7.4	Symmetries and conservation laws
	3.7.5	The space inversion, time reversal.

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	-	2	2	-	2	-	3	1	-	-	**2.29**	3	2	2	2.33
CO-2	3	1	-	-	2	3	1	-	2	2	3	-	**2.13**	3	1	2	2.00
CO-3	3	3	2	-	1	-	-	1	-	2	-	3	**2.14**	3	1	2	2.00
Avg	**3**	**2.33**	**2**	**2**	**1.6**	**3**	**1.5**	**1**	**2.5**	**1.6**	**3**	**3**	**2.18**	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- A Textbook of Quantum Mechanics, P. M. Mathews, K. Venkatesan, Tata McGraw Hill, 2024 • rinciples of Quantum Mechanics, R. Shankar, Springer, 2023
- Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Wiley, 2023
- Introduction to Quantum Mechanics, David J. Griffiths and Darrell F. Schroeter, Cambridge University Press, 2024
- Modern Quantum Mechanics, J. J. Sakurai and Jim Napolitano, Cambridge University Press, 2021
- Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, Robert Eisberg and Robert Resnick, Wiley, 2022
- Quantum Mechanics, G. Aruldhas, PHI Learning, 2022
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510336012**	**Name of Course** **Classical Mechanics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Solve exactly solvable eigenvalue problems in quantum mechanics and interpret their physical significance.
CO-2:	Explain the concepts of eigenvalues, eigenfunctions, and binding energy in the context of quantum systems.
CO-3:	Demonstrate an understanding of representations, transformations, and symmetries and their role in the formulation of quantum mechanics.

Detailed Syllabus

Unit-1. Lagrangian Formulations (15h)

1.1 Constraints
1.2 Generalized coordinates
1.3 D'Alembert's principle
1.4 Lagrange's equations
1.5 Cyclic or ignorable coordinates
1.6 Moving Coordinate System
1.7 Coordinate systems with relative translation motion
1.8 Rotating coordinate systems
1.9 The Coriolis systems
1.10 Motion on the earth

Unit-2. Motion of a rigid body (15h)

2.1 Introduction,
2.2 Euler's theorem,
2.3 Angular momentum and kinetic energy,
2.4 The inertia tensor,
2.5 Euler's equations of motion,
2.6 Torque free motion,
2.7 Euler's Angles, Motion of a symmetric top,
2.8 Notational motion.
2.3 Variational principle
2.3.1 Introduction
2.3.2 Configuration space
2.3.3 Some techniques of calculus of variation
2.3.4 The delta-notation,
2.4 Applications of the variational principle.

Unit-3 Lagrange's and Hamiltons equations & Canonical Transformations (15h)

3.1 Lagrange's and Hamiltons equations
3.1.1 Hamilton's principle,
3.1.2 Equivalence of Lagrange's and Newton's equations,
3.1.3 Advantages of the Lagrangian formulation -Electromechanical analogies,
3.1.4 Lagrange's undetermined multipliers, Lagrange's equation for non-holonomic systems,
3.1.5 Applications of the Lagrangian method of undetermined multipliers,
3.1.6 Hamilton's equations of motion, some applications of the Hamiltonian formulation,
3.1.7 Phase space,
3.1.8 Comments on the Hamiltonian formulation.
3.2 Canonical Transformations

3.2.1	Gauge transformation
3.2.2	Canonical transformation
3.2.3	Condition for transformation to be canonical,
3.2.4	Illustrations of canonical transformations.

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	-	-	-	2	3	-	3	2	1	-	-	2.33	3	2	2	2.33
CO-2	3	-	-	1	-	-	2	-	-	-	-	2	2	3	1	2	2.00
CO-3	3	3	1	-	1	1	3	-	2	-	-	1	1.88	3	1	2	2.00
Avg	3	3	1	1	1.5	2	2.5	3	2	1	-	1.5	2.07	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Classical Mechanics, R. G. Takwale, P. S. Puranik, McGraw Hill, 2023
- Classical Mechanics, J. C. Upadhyaya, Himalaya Publishing House, 2023
- Mechanics, D. S. Mathur, S. Chand Publishing, 2022
- Mechanics (University Physics Volume 1), Hugh D. Young, Roger A. Freedman, Pearson, 2023
- Introduction to Mechanics, Mahendra K. Verma, Universities Press, 2021
- Classical Mechanics, M. G. Venkatesh, Ane Books, 2022
- Principles of Mechanics, S. P. Taneja, S. Chand Publishing, 2023
- Classical Mechanics and General Properties of Matter, S. L. Kakani, C. Hemrajani, Viva Books, 2022
- Concepts of Classical Mechanics, P. S. Raghavan, PHI Learning, 2021
- University Physics (Volume I – Mechanics), Ronald Lane Reese, Cengage Learning, 2020
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 5

Course Code 255510536013	Name of Course PHYSICS PRACTICAL	Major
Credit: 05	Teaching Scheme: Practical (150)	Teaching Hours: 150

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of matter, electricity, magnetism, and optics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Acceleration due to gravity by Kater's pendulum (fixed knife edges).
2. Viscosity by Log decrement
3. Gonio meter
4. Mutual Inductance by Ballistic Galvanometer
5. Determination of Curie temperature of ferroelectric ceramic
6. Use of Excel for data analysis and graph plotting.
7. Heaviside Mutual Inductance Bridge.
8. Numerical integration by computer
9. Hartley Oscillator. Measurement of frequency by C.R.O. (Transistorized).
10. Half adder, Full adder and subtraction using IC 7483.
11. Series resonance. To find the band width and Q value of a coil.
12. Frequency response of CE amplifier
13. Study of voltage regulated circuit using IC7805

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.22**	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	
References			
• **Physics Record Book prepared by Dr. Kaushik Patel**			

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510436014**	**Name of Course** **Internship**	**ELECTIVE**
Credit: 04	**Teaching Scheme: Theory / Practical (120)**	**Teaching Hours: 120**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Apply theoretical knowledge of physics to real-world laboratory, industrial, or research problems through hands-on internship experience.
CO-2:	Demonstrate technical skills, use of scientific instruments, and data analysis methods relevant to the internship domain.
CO-3:	Communicate scientific findings effectively through reports, presentations, or project documentation in professional formats.
CO-4:	Develop teamwork, problem-solving, and ethical professional practices in a real workplace or research environment.

About Internship

DESCRIPTION: In-house as well as institutional work carried out by students under the supervision of a suitable guide. A bound copy of the Internship Report is necessary for evaluation.

OBJECTIVES:

1. Students should develop an understanding of the workflow in physics-related laboratories, industries, or research institutions.
2. Students should develop professional skills such as documentation, communication, discipline, and ethics.
3. The work undertaken should bridge the gap between theoretical knowledge and its practical application in physics.

STAGES OF INTERNSHIP

1. Orientation and Induction
2. Laboratory / Field Training / Project Work / Case Study
3. Report Writing
4. Presentation & Viva

SUGGESTED AREAS OF INTERNSHIP

Students should undertake work aligned with any field of physics to gain practical exposure to experimental or applied techniques in real-world settings.

1. **Condensed Matter Physics**: Crystal growth, material characterization, semiconductor devices.
2. **Optics & Photonics**: Laser experiments, fiber optics, optical instruments.
3. **Nuclear & Radiation Physics**: Radiation detection, dosimetry, nuclear instrumentation.
4. **Electronics & Instrumentation**: Circuit design, sensors, microcontrollers, data acquisition.

5. **Computational Physics**: Numerical simulations, MATLAB/Python-based modeling, data analysis.
6. **Energy & Environmental Physics**: Solar cells, renewable energy systems, environmental monitoring.
7. **Applied Physics / Industry**: Instrument calibration, quality testing, metrology labs.

ACTIVITIES & DELIVERABLES

a. Maintain a daily work log
b. Conduct experiments or observations
c. Attend team meetings or field visits
d. Submit a final internship report (10–15 pages)
e. Give a presentation

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	1	2	2	3	2	2	2	1	2	2.1	3	2	3	2.7
CO-2	2	2	2	1	3	3	2	3	2	2	1	2	2.1	2	2	2	2
CO-3	3	3	3	1	2	2	3	2	3	2	2	2	2.3	3	3	3	3
CO-4	3	2	3	1	2	2	3	2	3	2	2	2	2.3	3	3	3	3
Avg	2.8	2.3	2.8	1	2.3	2.3	2.8	2.3	2.5	2	1.5	2		2.8	2.5	2.8	**2.67**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Project-Based Learning (PBL)
CO-2	Mentored Apprenticeship/Coaching
CO-3	Reflective Practice/Journaling
CO-4	Collaborative Problem-Solving

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	10	Continuous Evaluation
	CO-2	10	
	CO-3	10	
	CO-4	10	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	15	Term End Examination
	CO-2	15	
	CO-3	15	
	CO-4	15	

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510236015**	**Name of Course** **Biosensors**	**Major** **Elective**
Credit: 02	**Teaching Scheme: Theory (30)**	**Teaching Hours: 30**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Explain principles, types, and features of thermal, optical, and vacuum sensors.
CO-2:	Apply biosensing elements to understand biosensor functions and uses. Also analyse immobilization methods and assess their use in biosensing.

Detailed Syllabus

Unit-1. Sensors and Biosensors (15h)

1.1 Sensors

1.1.1 What are Sensors / Transducers?
1.1.2 Importance of sensors
1.1.3 Principles of sensor
1.1.4 Static & dynamic characteristics,

1.2 **Characterizations-**

1.2.1 Electrical
1.2.2 Mechanical
1.2.3 High temperature

1.3 **Biosensors**

1.3.1 Introduction,
1.3.2 Applications of biosensor
1.3.3 Generation of biosensors
1.3.4 Glucose biosensor
1.3.5 Urea biosensor.

Unit-2. Bio Receptors and Immobilization techniques (15h)

2.1 Bio Receptors

2.1.1 Introduction
2.1.2 Enzymes
2.1.3 Examples of Enzyme Biosensors
2.1.4 Tissue Materials
2.1.5 Microorganism, Mitochondria
2.1.6 Antibodies
2.1.7 Nucleic Acid, Receptors.

2.2 Immobilization techniques

2.2.1 Adsorption
2.2.2 Micrencapsulation
2.2.3 Entrapment
2.2.4 Cross linking
2.2.5 Covalent Bonding
2.2.6 Modified electrodes

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	1	2	3	1	-	2	-	-	2	3	-	2	2	3	-	2.5
CO-2	3	-	2	3	3	3	-	3	-	-	3	-	2.86	2	3	-	2.5
Avg	3	1	2	3	2	3	2	3	-	2	3	-	2.5	2	3	-	2.5

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**		
			Written Test	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	20	10	5	5
	CO-2	20	10	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	30	Term End Examination		
	CO-2	30			

References

- Sensors and Transducers, D. Patranabis, Prentice Hall India, 2022
- Biosensors: An Introduction, Brian Eggins, Wiley-VCH, 2008
- Advances in Biosensors, Anthony P. F. Turner (Ed.), Jai Press, 1993
- Instrumental Analysis, Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Cengage Learning, 2020
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510236016**	**Name of Course** **Instrumentation**	**Major** **Elective**
Credit: 02	**Teaching Scheme: Theory (30)**	**Teaching Hours: 30**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Apply Beer-Lambert's law to interpret UV-Visible absorption data and analyse the effects of chromophores and auxochromes on absorption spectra.
CO-2:	Analyse the principles and instrumentation of X-ray spectroscopy techniques, including powder and single crystal diffraction, and evaluate their application in structural analysis.

Detailed Syllabus

Unit-1. Spectroscopy (15h)

1.1 UV spectroscopy

1.1.1 Introduction of instrumental methods and its classification
1.1.2 Introduction to UV – Visible Absorption Spectroscopy
1.1.3 Absorption laws Beer's-Lambert's law, its Principle
1.1.4 Applications and limitations
1.1.5 Types of transitions, Instrumentation
1.1.6 Chromophoric effect
1.1.7 Auxochromic effect
1.1.8 Bathochromic effect
1.1.9 Hypsochromic effect.

1.2 IR Spectroscopy

1.2.1 Introduction,
1.2.2 Principle
1.2.3 Theory
1.2.4 Instrumentation
1.2.5 Applications and limitations of- Infrared (IR)

Unit-2. X-ray Spectroscopy (15h)

2.1 X-ray

2.1.1 Introduction
2.1.2 History
2.1.3 Origin of X-rays

2.2 Instrumentation

2.2.1 Production of X-ray
2.2.2 Collimator
2.2.3 Monochromator
2.2.4 Detector

2.3 Diffraction Methods

2.3.1 Powder diffraction
2.3.2 Single crystal diffractometer

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	-	-	3	1	2	3	2	-	3	3	1	**2.33**	3	2	2	2.66
CO-2	3	-	-	3	-	-	-	2	3	1	-	-	**2.4**	3	2	1	2.33
Avg	**3**	**-**	**-**	**3**	**1**	**2**	**3**	**2**	**3**	**2**	**3**	**1**	**2.5**	3	2	2	2.66

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks			**Exam Component**		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	20	10	5	5
	CO-2	20	10	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	30	Term End Examination		
	CO-2	30			

References

- Spectroscopy, Gurdeep R. Chatwal, Himalaya Publishing House, 2022
- Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Cengage Learning, 2022
- Introduction to Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz, James R. Vyvyan, Cengage Learning, 2023
- Modern Spectroscopy, J. Michael Hollas, Wiley, 2022
- Analytical Instrumentation, Bela G. Liptak, CRC Press, 2021
- Spectroscopy and Instrumentation in Analytical Chemistry, David Kealey, P. J. Haines, Garland Science, 2020
- UV-VIS and IR Spectroscopy: Analytical Techniques, Heinz-Wolfgang Hübschmann, Wiley-VCH, 2022
- **Online Resources & Tools**:
  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics) Semester- 5		
Course Code **255510236017**	**Name of Course** **Statistics**	**Major** **Elective**
Credit: 02	**Teaching Scheme: Theory (30)**	**Teaching Hours: 30**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Apply measures like mean, median, mode, and standard deviation to interpret biological data.
CO-2:	Analyse binomial, Poisson, and normal distributions to solve problems.

Detailed Syllabus

Unit-1. Representation of Data (15h)

1.1 Definition and scope

1.2 Central tendency

1.2.1 Characteristics of ideal measure of central tendency
1.2.2 Mean
1.2.3 Mode
1.2.4 Median
1.2.5 Empirical relationship among mean, Mode and median,
1.2.6 Merits, demerits and uses of mean, mode and median
1.2.7 Graphic location of median and mode,
1.2.8 Selection of appropriate measure of central tendency

1.3 Dispersion & Deviation

1.3.1 Need of measures of dispersion,
1.3.2 Mean deviation
1.3.3 Standard deviation

Unit-2. Probability and Standard Probability distributions (15h)

2.1 Random experiment

2.2 Probability

2.2.1 Definition
2.2.2 Elementary properties of probability,
2.2.3 Mutually exclusive events,
2.2.4 Dependant and independent events,
2.2.5 Addition rule and multiplication rule for probability (without proof),
2.2.6 Conditional probability**,**

2.3 Bayes's theorem,

2.4 Variables

2.4.1 Random variable,
2.4.2 Discrete and continuous random variables

2.5 Probability distributions

2.5.1 Bernoulli trials,
2.5.2 Binomial and Poisson distributions and their properties,
2.5.3 Mean and variance of these distributions,
2.5.4 Recurrence relations for probabilities related to binomial distribution and Poisson distributions,
2.5.5 Normal distribution and its properties,
2.5.6 Standard normal variable,
2.5.7 Fitting of binomial, Poisson and normal distributions.

Mapping Matrix of POs, PSOs, and COs																	
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	3	2	-	-	1	-	-	2	1	1	2	1.88	3	2	2	**2.66**
CO-2	3	-	1	2	1	-	-	2	-	-	1	3	1.86	3	2	2	**2.66**
Avg	3	3	1.5	2	1	1	-	2	2	1	1	2.5	2	3	2	1	**2.66**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks			**Exam Component**		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	20	10	5	5
	CO-2	20	10	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	30	Term End Examination		
	CO-2	30			

References

- Fundamentals of Mathematical Statistics, S. C. Gupta, V. K. Kapoor, Sultan Chand & Sons, 2023
- Introduction to the Practice of Statistics, David S. Moore, George P. McCabe, Bruce A. Craig, W. H. Freeman, 2023
- Statistics, Robert S. Witte, John S. Witte, Wiley, 2022
- Basic Statistics, B. L. Agarwal, New Age International Publishers, 2023
- Biostatistics, B. K. Mahajan, Jaypee Brothers Medical Publishers, 2023
- An Introduction to Biostatistics, P. S. S. Sundar Rao, J. Richard, PHI Learning, 2022
- Statistics: Theory, Methods and Applications, D. C. Sancheti, V. K. Kapoor, Sultan Chand, 2021
- **Online Resources & Tools**:

  SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 6		
Course Code **255510336018**	**Name of Course** **Nuclear Physics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Demonstrate a fundamental understanding of nuclear physics, including nuclear structure, stability, and radioactivity.
CO-2:	Explain the basic theoretical concepts related to elementary particles and their interactions.
CO-3:	Understand the principles of nuclear energy production and its applications in power generation and technology.

Detailed Syllabus

Unit-1. Constituents of Nucleus (15h)

1.1 Introduction,

1.2 Rutherford Scattering and estimation of the nuclear size, Measurement of nuclear radius

1.3 Constituents of the nucleus and their properties,

1.4 Nuclear spin, moments and statistics.

1.5 Alpha Rays

1.5.1 Range of alpha particles

1.5.2 Disintegration energy of the spontaneous alpha decay

1.5.3 Alpha decay paradox - barrier penetration.

Unit-2. Beta Rays & Gamma Rays (15h)

2.1 Beta Rays

2.1.1 Introduction

2.1.2 Continuous Beta ray spectrum - difficulties encountered to understand it

2.1.3 Pauli's Neutrino Hypothesis

2.1.4 Fermi's theory of Beta decay

2.1.5 The detection of neutrino

2.1.6 Parity

2.1.7 Non-conservation in Beta decay.

2.2 Gamma Rays

2.2.1 Introduction

2.2.2 Gamma ray emission- selection rules

2.2.3 Internal conversion

2.2.4 Nuclear Isomerism

Unit-3 The liquid drop model of the nucleus (15h)

3.1 The liquid drop model of the nucleus

3.1.1 Introduction

3.1.2 Binding energies of nuclei: plot of B/A against A

3.1.3 Weizsacher's semi

3.2 Empirical mass formula Nucleon emission.

3.3 Nuclear Energy

3.3.1 Introduction

3.3.2 Neutron induced fission,

3.3.3 Asymmetrical fission- Mass Yield

3.3.4 Emission of delayed neutrons by fission fragments

3.3.5 Energy released in the fission of 235U

3.3.6 Fission on lighter nuclei

3.3.7 Fission chain reaction

3.3.8 Neutron cycle in a thermal nuclear reactor

3.4 Nuclear reactors

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	1	2	1	3	-	2	2	1	-	2	-	1.89	3	2	2	2.33
CO-2	3	1	2	2	2	1	2	2	1	-	3	2	1.91	3	1	2	2.00
CO-3	3	3	1	3	2	3	3	-	-	-	3	-	2.63	3	1	2	2.00
Avg	3	1.6	1.6	2	2.33	2	2.3	2	1	-	2.67	2	2.14	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Nuclear Physics: An Introduction, S. B. Patel, New Age International, 2023
- Introduction to Nuclear Physics, H. A. Enge, Addison-Wesley, 2020
- Nuclear Physics, D. C. Tayal, Himalaya Publishing House, 2022
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 6

Course Code 255510236019	Name of Course PHYSICS PRACTICAL	Major
Credit: 02	Teaching Scheme: Practical (60)	Teaching Hours: 60

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of matter, radioactive material, and particles through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Nuclear Decay (Simulation)
2. Determination of dead time of G.M. tube.
3. Comparison of relative intensities of different sources using G.M. Tube.
4. Determination of Operating Voltage for Scintillation Detector
5. Activity measurement of Gamma – Source (relative method) Using Scintillation Detector

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	1	3	1	-	2	-	-	2	1	-	-	**1.86**	3	2	2	2.33
CO-2	2	2	3	1	3	-	-	-	-	-	2	2	**2.14**	3	1	2	2.00
CO-3	1	-	3	-	-	-	2	2	2	-	3	-	**2.17**	3	1	2	2.00
Avg	**2**	**1.5**	**3**	**1**	**3**	**2**	**2**	**2**	**2**	**1**	**2.5**	**2**	**2.06**	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

	COs	Marks	Exam Component
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 6		
Course Code **255510336020**	**Name of Course** **Electronics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Explain the fundamental concepts of feedback in amplifiers and analyze its impact on gain, bandwidth, and stability.
CO-2:	Demonstrate an understanding of the basic principles and applications of operational amplifiers in analog circuits.
CO-3:	Describe the construction, operation, and characteristics of field-effect transistors (FETs) and assess their role in electronic circuit design.

Detailed Syllabus

Unit-1. Feedback (15h)

1.1 Negative Feedback in transistor amplifier:

1.1.1 General theory of feedback
1.1.2 Reasons for negative feedback,
1.1.3 Loop types of negative feedback in transistor circuits.

1.2 Transistor Oscillators

1.2.1 Introduction,
1.2.2 Effect of positive feedback
1.2.3 Requirements for oscillations
1.2.4 The phase shift oscillator
1.2.5 Wien bridge oscillator
1.2.6 Resonant circuit oscillators (Colpit and Hearley oscillators),
1.2.7 The maximum frequency of oscillation of a transistor.

Unit-2. FET AND OPAMP (15h)

2.1 Field effect transistor (FET) amplifier

2.1.1 Introduction
2.1.2 Advantages and disadvantages of the FET
2.1.3 Basic construction of the JFET (Revision)
2.1.4 Characteristics curve of the JFET
2.1.5 Principle of operation of the JFET
2.1.6 Effect of the VDS on channel conductivity
2.1.7 Channel ohmic region and pinch off region
2.1.8 Characteristics parameters of the FET(Revision)
2.1.9 Common source AC amplifier

2.2 Operational Amplifier (OpAmp)

2.2.1 Introduction
2.2.2 The operational amplifier
2.2.3 The inverting differential operational amplifier
2.2.4 The non-inverting differential operational amplifier
2.2.5 The differential amplifier, General purpose
2.2.6 IC operational amplifier, Applications of operational amplifier

Unit-3 Regulated Power Supply and CRO (15h)

3.1 Regulated Power Supply

3.1.1 Introduction
3.1.2 Stabilization
3.1.3 Limitations of Zener diode regulator
3.1.4 Transistor series voltage
3.1.5 Regulator,

3.1.6 Transistor shunt voltage regulator
3.1.7 A series regular with two transistors
3.1.8 Current regulator

3.2 **Cathode ray oscilloscope (CRO)**

3.2.1 CRT,
3.2.2 Electron gun
3.2.3 Deflecting plates
3.2.4 Screen, methods of focusing
3.2.5 Deflection systems
3.2.6 Mathematical expression for electrostatic deflection sensitivity
3.2.7 Electromagnetic deflection system
3.2.8 Magnetic deflection in CRT
3.2.9 Time base (without circuits)
3.2.10 CRO Parts, operation of a typical oscilloscope control,
3.2.11 Uses of CRO

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	1	3	1	-	2	-	-	2	1	-	-	1.86	3	2	2	2.33
CO-2	2	2	3	1	3	-	-	-	-	-	2	2	2.14	3	1	2	2.00
CO-3	1	-	3	-	-	-	2	2	2	-	3	-	2.17	3	1	2	2.00
Avg	2	1.5	3	1	3	2	2	2	2	1	2.5	2	2.06	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Electronic Devices and Circuit Theory, Robert L. Boylestad, Louis Nashelsky, Pearson, 2023
- Principles of Electronics, V. K. Mehta, Rohit Mehta, S. Chand Publishing, 2023
- Basic Electronics: Devices, Circuits and IT Fundamentals, B. L. Theraja, S. Chand Publishing, 2022
- Electronic Principles, Albert Malvino, David Bates, McGraw Hill Education, 2023
- Operational Amplifiers and Linear Integrated Circuits, Ramakant A. Gayakwad, Pearson, 2022
- Electronic Devices and Circuits, David A. Bell, Oxford University Press, 2022

- Fundamentals of Electronics, J. Millman, C. C. Halkias, Tata McGraw Hill, 2023
- Modern Digital Electronics, R. P. Jain, McGraw Hill Education, 2022
- A Textbook of Applied Electronics, R. S. Sedha, S. Chand Publishing, 2023
- Electronic Instrumentation and Measurements, David A. Bell, Oxford University Press, 2023
- Electronic Devices and Circuits: An Introduction, Allen Mottershead, Prentice-Hall India, 2022
- **Online Resources & Tools**:

  SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics)
Semester- 6

Course Code 255510236021	Name of Course PHYSICS PRACTICAL	Major
Credit: 02	Teaching Scheme: Practical (60)	Teaching Hours: 60

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of Electronics components and equipment through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Negative feedback
2. Colpit oscillators
3. FET characteristics
4. Frequency response of a common source FET amplifier.
5. Study of Hysterisis using C.R.O.
6. Zener diode as voltage regulator
7. Regulated power supply
8. A.C. Circuit analysis by C.R.O. Measurement of frequency and phase difference
9. IC-741 OPAMP
10. Numerical differentiation by computer

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	2.22	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 6		
Course Code **255510336022**	**Name of Course** **Mathematical Physics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Demonstrate fundamental understanding of mathematical physics concepts used to describe physical systems and solve scientific problems.
CO-2:	Explain the basic principles of numerical techniques and apply them to solve differential equations relevant to physical phenomena.
CO-3:	Understand and apply essential mathematical tools and methods to analyze and interpret physical problems across various domains.

Detailed Syllabus

Unit-1. Numerical Techniques & Differential equations (15h)

1.1 Numerical Techniques

1.1.1 Curve Fitting: Introduction
1.1.2 Least squares method, Fitting a straight line
1.1.3 Fitting a Parabola
1.1.4 Fitting a Curve of the form y=a x b
1.1.5 Fitting an exponential curve
1.1.6 Integration: Integration by Trapezoidal Rule
1.1.7 Simpson's (1/3) rule
1.1.8 Eigen value and its problems.

1.2 Differential equations

1.2.1 Some partial differential equations in physics
1.2.2 The method of Separation of variables
1.2.3 Separation of Helmboltz equation in Cartesian coordinates,
1.2.4 In spherical polar and cylindrical Coordinates
1.2.5 Laplace's equation in various coordinates
1.2.6 Choice of coordinate system and separability of a partial differential equation
1.2.7 Parabolic coordinates system
1.2.8 Prolate Spheroidal coordinates system
1.2.9 Various examples based on the separation of variables

Unit-2. 2nd Order Differential Equations (15h)

2.1 Ordinary and Singular points,

2.1.1 Series solution around an ordinary point
2.1.2 Series solution around a regular singular point: the method of Frobenius
2.1.3 Getting a second solution
2.1.4 Alternative method of getting the second solution
2.1.5 System of linear first order differential equations
2.1.6 Non-linear differential equations
2.1.7 Related examples.

Unit-3 Some special functions in Physics (15h)

3.1 Bessel functions,

3.1.1 Bessel functions of the second kind,
3.1.2 Henkel functions
3.1.3 Spherical Bessel functions

3.2 Legendre polynomials

3.2.1 Associated Legendre polynomials and spherical harmonics

3.2.2 Hermite polynomials
3.2.3 Laguerre polynomials
3.2.4 The gamma function
3.2.5 The Dirac delta function, examples.

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	2	1	3	2	2	-	2	2	2	-	**2.1**	3	2	2	**2.33**
CO-2	3	-	1	2	-	-	-	-	-	2	-	-	**2**	3	1	2	**2.00**
CO-3	3	2	2	1	2	2	-	-	2	2	-	2	**2**	3	1	2	**2.00**
Avg	**3**	**2**	**1.6**	**1.3**	**2.5**	**2**	**2**	**-**	**2**	**2**	**2**	**2**	**2.03**	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Mathematical Methods for Physicists, George B. Arfken, Hans J. Weber, Frank E. Harris, Academic Press, 2023
- Advanced Engineering Mathematics, Erwin Kreyszig, Wiley, 2023
- A Textbook of Mathematical Physics, H. K. Dass, S. Chand Publishing, 2023
- Mathematical Physics, B. D. Gupta, Vikas Publishing House, 2022
- Mathematical Methods in the Physical Sciences, Mary L. Boas, Wiley, 2023
- Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge University Press, 2022
- Differential Equations and Their Applications, M. Braun, Springer, 2021
- Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, McGraw Hill Education, 2023
- Special Functions for Scientists and Engineers, W. W. Bell, Courier Dover Publications, 2021
- Special Functions and Their Applications, N. N. Lebedev, Dover Publications, 2022
- **Online Resources & Tools**:

SWAYAM Courses: https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 6

Course Code 255510236023	Name of Course PHYSICS PRACTICAL	Major
Credit: 05	Teaching Scheme: Practical (150)	Teaching Hours: 150

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of Mathematical formulas, computer and theoretical physics through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Numerical differentiation by computer
2. Analysis of error
3. Curve Fitting by Least squares method, Fitting a straight line, Fitting a Parabola
4. Curve Fitting by Fitting a straight line and Fitting a Parabola
5. Special functions Bessel functions of the second kind
6. Legendre polynomials,
7. Associated Legendre polynomials
8. spherical harmonics
9. Use of Excel for data analysis.

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	**2.22**	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

Program – B.Sc. (Physics) Semester- 6		
Course Code **255510336024**	**Name of Course** **Solid State Physics**	**Major**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1:	Demonstrate fundamental knowledge of solid-state physics, including crystal structure, bonding, and electronic properties of solids.
CO-2:	Explain the basic concepts and theoretical foundations of dielectric materials and superconductivity.
CO-3:	Describe the properties, types, and applications of superconductors in modern physics and technology.

Detailed Syllabus

Unit-1. Free Electron Fermi Gas (15h)

1.1 Free electron Fermi Gas

1.1.1 Introduction Energy levels in one dimension
1.1.2 Effect of temperature on the Fermi-Dirac distribution
1.1.3 Free electron gas in three dimensions and density of states
1.1.4 Heat capacity of the electron gas and experimental heat capacity of metals
1.1.5 Electrical conductivity and ohm's law,

1.2 Electrical Resistivity and Conductivity

1.2.1 Experimental electrical resistivity of metals
1.2.2 Thermal conductivity of metals
1.2.3 Ratio of thermal to electrical conductivity.

Unit-2 Theory of Dielectrics (15h)

2.1 Polarization

2.1.1 Dielectric constant
2.1.2 Local Electric field
2.1.3 Dielectric polarizability
2.1.4 Sources of polarizability
2.1.5 Theory of electric polarizability and optical absorption
2.1.6 Ionic polarization
2.1.7 Polarization from dipole orientation
2.1.8 Dielectric losses

2.2 Applications to optical phonon modes in ionic crystals,
2.3 The longitudinal optical mode
2.4 The transverse optical mode
2.5 The interaction of electromagnetic waves with optical modes
2.6 Application to the motion of electrons in polar crystals Related examples.

Unit-3 Super conductivity (15h)

3.1 Sper Conductor

3.1.1 Experimental Survey
3.1.2 Occurrence of superconductivity
3.1.3 Destruction of superconductivity by magnetic field
3.1.4 Meissner effect
3.1.5 Heat capacity
3.1.6 Energy gap
3.1.7 Microwaves and infrared properties
3.1.8 Isotope effect
3.1.9 Theoretical Survey
3.1.10 London equation

3.1.11 BCS theory of superconductivity
3.1.12 Flux quantization in a superconducting ring
3.1.13 Type –I & Type -II superconductors

Mapping Matrix of POs, PSOs, and COs																	
	POs													PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	-	2	-	2	2	1	-	2	3	3	-	2.25	3	2	2	2.33
CO-2	3	2	1	-	-	2	3	-	2	2	2	2	2.11	3	1	2	2.00
CO-3	3	2	3	2	-	2	-	-	1	-	2	-	2.14	3	1	2	2.00
Avg	3	2	2	2	2	2	2	-	1.6	2.5	2.33	2	2.17	**3**	**1.33**	**2**	**2.11**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture, Ask & Know Technique, Group Discussion, Story Telling
CO-2 (Unit: 2)	Lecture, Ask & Know Technique, Group Discussion, Assignment, Presentation
CO-3 (Unit: 3)	Lecture, Ask & Know, Technique, Gamification, Story Telling

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Solid State Physics, S. O. Pillai, New Age International Publishers, 2023
- Introduction to Solid State Physics, Charles Kittel, Wiley, 2024
- Solid State Physics: Structure and Properties of Materials, M. A. Wahab, Narosa Publishing House, 2023
- Solid State Physics, Ashcroft and Mermin, Cengage Learning, 2023
- Elements of Solid State Physics, J. P. Srivastava, PHI Learning, 2022
- Fundamentals of Solid State Physics, B. S. Saxena, R. C. Gupta, C. P. Saxena, Pragati Prakashan, 2022
- Solid State Physics and Electronics, R. K. Puri, V. K. Babbar, S. Chand Publishing, 2023
- **Online Resources & Tools**:

  SWAYAM Courses**:** https://swayam.gov.in

Program – B.Sc. (Physics)
Semester- 6

Course Code 255510236025	Name of Course PHYSICS PRACTICAL	Major
Credit: 02	Teaching Scheme: Practical (30)	Teaching Hours: 30

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Apply and illustrate the concepts of properties of Matter, Super Conductor, Semiconductor etc through experiments.

CO-2: Gain practical knowledge of measuring instruments and laboratory procedures used to analyze and interpret experimental results.

CO-3: Develop the ability to use equipment, collect data, and communicate findings in basic physics experiments.

Detailed Syllabus

1. Effect of temperature on resistivity of metal
2. Determination of Dielectric constant
3. Hall effect
4. Effect of magnetic field on resistivity of metal
5. To study dielectric polarization
6. Fresnel's Biprism
7. To analyse elliptically polarized light using Babinate compensator.

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	2	2	2	2	2	2	2	2	2	**2.17**	3	2	2	**2.33**
CO-2	2	3	3	2	2	2	3	2	2	2	2	2	**2.25**	2	3	2	**2.33**
CO-3	2	2	3	2	2	3	3	2	2	2	2	2	**2.25**	2	3	3	**2.67**
Avg	**2.33**	**2.33**	**3.00**	**2.00**	**2.00**	**2.33**	**2.67**	**2.00**	**2.00**	**2.00**	**2.00**	**2.00**	2.22	**2.33**	**2.67**	**2.33**	**2.44**

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-3	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	13	Continuous Evaluation
	CO-2	13	
	CO-3	14	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Term End Examination
	CO-2	20	
	CO-3	20	

References

- **Physics Record Book prepared by Dr. Kaushik Patel**

MINOR COURSE (Chemistry)

Program – B.Sc. (Physics) Semester- 1		
Course Code **254510337001**	**Name of Course** **Physical Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Interpret ionic equilibrium in terms of acid-base reactions, pH scale, Hydrolysis of salt, and buffer systems.

CO-2: Describe the relationship between physical properties and molecular structure

CO-3: Recognize the catalytic processes and adsorption phenomena

Detailed Syllabus

Unit-1 Ionic equilibrium (15h)

1.1 Degree of ionization **(1h)**

1.2 Ostwald dilution law and its limitations **(1h)**

1.3 pH scale **(2h)**

- Definition of pH and importance of pH scale
- Relation between pH and concentration of H^+ in solution
- pH range of acidic, basic solution
- Introduction about pOH, relation between pH and pOH, ionic product of water (K_w)

1.4 Hydrolysis of salts (from weak acid [HA] and strong base [BOH]) including derivation of

- $K_h = \frac{[HA][OH^-]}{[A^-]}$ **(2h)**
- $K_h = \frac{K_w}{K_a}$
- $h = \sqrt{\frac{K_h}{C}}$
- $pH = \frac{1}{2}[pK_w + pK_a + \log C]$

1.5Hydrolysis of salts (from weak base [BOH] and strong acid [HA]) including derivation of

- $K_h = \frac{[BOH][H^+]}{[B^+]}$ **(2h)**
- $K_h = \frac{K_w}{K_b}$
- $h = \sqrt{\frac{K_h}{C}}$
- $pH = \frac{1}{2}[pK_w - pK_b - \log C]$

1.6 Hydrolysis of salts (from weak acid [HA] and weak base [BOH]) including derivation of

- $K_h = \frac{[HA][BOH]}{[A^-][B^+]}$ **(2h)**
- $K_h = \frac{K_w}{K_a \times K_b}$
- $h = \sqrt{K_h}$
- $pH = \frac{1}{2}[pK_w + pK_a - pK_b]$

1.7 Buffer solutions **(2h)**

- Properties of buffer solutions

- Buffer capacity and buffer limit of buffer solution
- pH of buffer formed from weak acid and its salt including derivation of Henderson-Hasselbach equation
- pOH of buffer formed from weak base and its salt including derivation of Henderson-Hasselbach equation
- Action of buffer solutions in adjustment of pH during addition of acid or Base
- Buffer standards
- Importance of buffer solutions

1.8 Numericals based on topics 1.3 to 1.7 **(3h)**

Unit-2. Physical properties and molecular structure (15h)

2.1 Additive and constitutive properties **(1h)**

2.2 Molar volume: **(2h)**

- Additivity of molar volume
- Calculation of approximate molar volumes of given compound

2.3 Surface tension: **(2h)**

- Definition, unit
- Derivation of formula of relative surface tension of liquid
- Use of stalagmometer in determination of relative surface tension of liquid
- Numericals

2.4 Parachor:**(2h)**

- Relation between parachor, surface tension and molarvolume
- Calculation of approximate parachor of given compound
- Application of parachor
- Numericals

2.5 Viscosity: **(2h)**

- Definition, unit
- Derivation of formula of relative viscosity of liquid
- Use of Ostwal's viscometer in determination of relative viscosity of given liquid
- Numericals

2.6 Molar refraction: **(2h)**

- Definition and applications
- Molar refraction of mixture
- Measurement of refraction index by Abbe refractometer
- Numerical

2.7 Optical activity: **(2h)**

- Definition, measurement by polarimeter
- d / (+) / dextro, l /(-) / levo concept
- Numericals

2.8 Dipole moment, its measurement and its application **(2h)**

Unit- 3(A) Catalysis (8h)

3(A).1 Definition of catalyst and catalysis **(1h)**

3(A).2 Types of catalyst: Positive catalyst, negative catalyst and auto catalyst **(1h)**

3(A).3 Catalytic reaction:Homogeneous catalytic reaction and Heterogeneous catalytic reaction **(1h)**

3(A).4 Characteristics of catalyst **(1h)**

3(A).5 Action of finely divided catalyst **(1h)**

3(A).6 Catalytic promoters or activators **(1h)**

3(A).7 Catalytic poisons or anticatalysts **(1h)**

3(A).8 Enzyme catalyst: definition and characteristics **(1h)**

Unit- 3(B) Adsorption (7h)

3(B).1 Definition of adsorption, absorption, Positive adsorption, negative adsorption, absorbate, desorption **(1h)**

3(B).2 Types of adsorption (physical adsorption, chemical adsorption) **(2h)**
3(B).3 Adsorption of gases by solids **(1h)**
3(B).4 Freudlich and langmuir adsoption isotherm(derivation) **(2h)**
3(B).5 Application of adsorption **(1h)**

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	3	2	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	–	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	2	3	3	1	–	–	2	–	–	–	–	–	2.17	2	2	3	2.33
Avg	2.67	2.67	2.5	1.0	–	2.0	1.67	–	–	–	–	–		2.67	1.67	2.67	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
Continuous Comprehensive Evaluation 40 Marks	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Puri, B. R., Sharma, L. R., & Pathania, M. S. (2022). Principles of Physical Chemistry (48th ed.). Vishal Publishing Co.
- Mahan, B.**h)**., & Meyers, R. J. (2020). University Chemistry (5th ed.). Pearson Education.
- Bahl, A., Bahl, B. S., & Tuli, G. D. (2023). Essentials of Physical Chemistry (28th rev. ed.). S. Chand & Company Ltd.
- Kotz, J. C., & Treichel, P. (1999). Chemistry and chemical reactivity (4th ed.). Saunders College Publishing.
- Skoog, D. A., West, D. M., & Holler, F. J. (1996). Fundamentals of analytical chemistry (7th ed.). Saunders College Publishing.
- Harris, D. C. (2003). Quantitative chemical analysis (6th ed.). W.H. Freeman and Company.
- Atkins, P., de Paula, J., & Keeler, J. (2022). Atkins' physical chemistry (12th ed.). Oxford University Press.

- Kapoor, K. L. (2023). A textbook of physical chemistry (Vol. 1–5). Macmillan India.
- Athawale, V. D., & Mathur, P. (2022). Experimental physical chemistry. New Age International Publishers.
- McQuarrie, D. A., & Simon, J. D. (2023). Physical chemistry: A molecular approach. University Science Books.
- Raj, G. (2024). Advanced physical chemistry . Goel Publishing House.
- Viswanathan, B., Sivasanker, S., & Ramaswamy, A. V. (2011). Catalysis: Principles and applications (Reprint ed.). Narosa Publishing House.
- **Online Resources & Tools**:
  SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 1		
Course Code **254510237002**	**Name of Course** **Physical Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: prepare chemical solutions accurately

CO-2: analyze physical properties of liquids and ability to determine catalytic and adsorption activity

Detailed Syllabus

(A) Solution preparation (24h)

(1) General introduction, Percentage solution: %v/v, %w/v **(4h)**

(2) Preparation and standardization of sodium hydroxide solution (approximately 0.1 N) **(4h)**

(3) To determine normality of given HCl/HNO_3 solution using standard sodium hydroxide Solution **(4h)**

(4) Preparation and standardization of hydrochloric acid solution (approximately 0.1 N) **(4h)**

(5) To determine normality of given NaOH/KOH solution using standard hydrochloric acid solution**(4h)**

(6) Preparation of molar and normal solution of H_2SO_4 and Na_2CO_3 **(4h)**

(B) Experiments of Physical chemistry (28h)

(1) To measure the density of a given liquid by R.D. bottle **(4h)**

(2) To determine the relative surface tension of a liquid with respect to water at room temperature by Stalagmometer **(4h)**

(3) To determine the surface tension of methyl alcohol, ethylalcohol and n-hexane at room temperature and calculate the atomic parachors of carbon,hydrogen and oxygen **(8h)**

(4) To determine the relative viscosity of a liquid with respect to water at room temperature by Ostwald's Viscometer **(4h)**

(5) To determine the composition of a given mixture consisting of two miscible liquids, A and B by viscosity Measurement **(4h)**

(6) To determine the refractive index of a given liquid and find its specific and molar refractivities **(4h)**

(C) Catalysis and Adsorption (8h)

(1) To determine the relative strength between HCl and H_2SO_4 by studying hydrolysis of methyl acetate **(4h)**

(2) To study the adsorption of an organic acid by Animal Charcoal. (Acetic acid /Oxalic acid) **(4h)**

Mapping Matrix of POs, PSOs, and COs

COs	POs													PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	2	3	2	2.33
CO-2	3	3	3	1	–	–	2	–	–	–	–	–	2.00	3	2	2	2.33
Avg	3.0	2.5	3.0	1.0	–	2.0	2.0	–	–	–	–	–		2.50	2.50	2.00	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Ahluwalia, V. K., & Sharma, S. (2022). ***Practical chemistry: For B.Sc. students*** (Latest ed.). University Press.
- Patil, R. S., & Sawant, R. M. (2023). ***Laboratory manual of analytical chemistry*** (2nd ed.). Himalaya Publishing House.
- Furniss, B. S.,Hannaford, A. J., Smith, P. W. G., & Tatchell, A. R. (2021). ***Vogel's textbook of practical organic chemistry*** (5th ed., Reprint). Pearson Education.

Program – B.Sc. (Physics) Semester- 2		
Course Code **254510337003**	**Name of Course** **Inorganic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: relate the elements and their periodic relationships

CO-2: express occurrence, chemical and physical properties of s, p, d and f-block elements

CO-3: recognize the importance of chemical elements and their diverse applications

Detailed Syllabus

Unit- 1(A) s- Block Elements (Alkali and Alkaline earth metals) (10h)

Group-1: Alkali metals

1(A).1 General introduction, electronic configuration, occurrence **(1h)**

1(A).2 Anomalous properties of the Lithium **(0.5h)**

1(A).3 Diagonal Relationship between Lithium and Magnesium **(0.5h)**

1(A).4 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii) **(1h)**

1(A).5 Trends in chemical reactivity with oxygen, water, hydrogen and halogens **(1h)**

1(A).6 Biological importance of sodium and potassium **(0.5h)**

1(A).7 Uses of Alkali metals **(0.5h)**

Group-2: Alkaline earth metal

1(A).8 General introduction, electronic configuration, occurrence **(1h)**

1(A).9 Anomalous properties of the Beryllium **(0.5h)**

1(A).10 Diagonal Relationship between Beryllium and Aluminium **(0.5h)**

1(A).11 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii) **(1h)**

1(A).12 Trends in chemical reactivity with oxygen, water, hydrogen and halogens **(1h)**

1(A).13 Biological importance of Mg and Ca **(0.5h)**

1(A).14 Uses of Alkaline earth metals **(0.5h)**

Unit- 1 (B)d-Block Elements Transition Elements (First, second and third Transition Series (5h)

1(B).1 General introduction, electronic configuration **(1h)**

1(B).2 Physical properties of transition metals **(0.5h)**

1(B).3Variation in Atomic and Ionic Sizes of Transition Metals **(1h)**

1(B).4 Ionisation Enthalpies of Transition Metals **(0.5h)**

1(B).5 Oxidation states of Transition Metals **(0.5h)**

1(B).6 Magnetic Properties of Transition Metals **(0.5h)**

1(B).7 Formation of coloured ions **(0.5h)**

1(B).8 Catalytic properties of Transition Metals **(0.5h)**

Unit- 2 p-Block Elements (10h)

2.1 General Introduction to p-Block Elements **(0.5h)**

Group 13 elements: Boron Family

2.2 General introduction, electronic configuration, occurrence **(0.5h)**

2.3 Anomalous properties of the Boron **(0.5h)**

2.4 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.5 Physical properties and chemical reactivity (with air, acids, alkalies and halogens) **(0.5h)**

2.6 Uses of boron, aluminium and their compounds **(0.5h)**

Group 14 elements: Carbon Family

2.7 General introduction, electronic configuration, occurrence **(0.5h)**

2.8 Anomalous properties of the carbon **(0.5h)**

2.9 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.10 Physical properties and chemical reactivity (with oxygen, water and halogens) **(0.5h)**

2.11 Allotropes of carbon (Diamond, Graphite and Fullerenes) and Uses of carbon **(0.5h)**

Group 15 elements: Nitrogen Family

2.12 General introduction, electronic configuration, occurrence **(0.5h)**

2.13 Anomalous properties of the Nitrogen **(0.5h)**

2.14 Trends in the variation of properties (such as ionization enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.15 Physical properties and chemical reactivity (with hydrogen, oxygen, halogens and metals) **(0.5h)**

2.16 Uses of nitrogen and allotropes of Phosphorus (White, Red and Black) **(0.5h)**

Group 16 elements: Oxygen Family

2.17 General introduction, electronic configuration, occurrence **(0.5h)**

2.18 Anomalous properties of the Oxygen **(0.5h)**

2.19 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.20 Physical properties and chemical reactivity (with hydrogen, oxygen and halogens) **(0.5h)**

2.21 Allotropes of Sulphur (Rhombic, Monoclinic) **(0.5h)**

2.22 Uses of oxygen, ozone, sulphur dioxide and sulphuric acid **(0.5h)**

Group 17 elements: Halogen Family

2.23 General introduction, electronic configuration, occurrence **(0.5h)**

2.24 Anomalous properties of the Fluorine **(0.5h)**

2.25 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii, electronegativity) **(0.5h)**

2.26 Physical properties and chemical reactivity (with hydrogen, oxygen, metals and other halogens) **(0.5h)**

Group 18 elements: Noble gas Family

2.27 General introduction, electronic configuration, occurrence **(0.5h)**

2.28 Trends in the variation of properties (such as ionization enthalpy, electron gain enthalpy, atomic and ionic radii) **(0.5h)**

2.29 Physical properties and chemical reactivity **(0.5h)**

2.30 Uses of noble gases **(0.5h)**

Unit- 3(A) The lanthanide series (6h)

3(A).1 Electronic configuration **(1h)**

3(A).2 Oxidation states **(1h)**

3(A).3 Magnetic properties **(1h)**

3(A).4 Colour and absorption spectra of lanthanide ions **(1h)**

3(A).5 Lanthanide contraction **(1h)**

3(A).6 Separation and purification of lanthanides :Ion exchange and solvent extraction methods **(1h)**

Unit -3(B) The Actinide series (9h)

3(B).1 Electronic configuration **(1h)**

3(B).2 Oxidation states **(1h)**

3(B).3 Magnetic properties **(1h)**

3(B).4 Colour and absorption spectra of actinide ions **(1h)**

3(B).5 Actinide contraction **(1h)**
3(B).6 Nuclear synthesis of trans uranic elements **(1h)**
3(B).7 Chain reaction **(1h)**
3(B).8 Importance of uranium **(1h)**
3(B).9 Comparison with lanthanides **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	2	–	–	2	1	–	–	–	–	–	2.00	3	1	2	2.00
CO-2	3	3	2	1	–	–	2	–	–	–	–	–	2.20	3	1	2	2.00
CO-3	3	2	2	2	1	–	2	1	–	–	–	2	2.00	3	1	3	2.33
Avg	3.0	2.33	2.0	1.5	1.0	2.0	1.67	1.0	–	–	–	2.0		3.0	1.0	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

References

- Shriver, D. F., & Atkins, P. W. (2024). Inorganic Chemistry (7th ed.). Oxford University Press.
- Tandon, O. P. (2023). Inorganic Chemistry (6th ed.). S. Chand Publishing.
- Gerloch, M., & Constable, E. C. (2025). Transition Metal Chemistry: The Valence Shell in d Block Chemistry. Wiley.
- Cotton, F. A., Wilkinson, G., & Gaus, P. L. (2022). Basic Inorganic Chemistry (3rd Indian Adapted ed.). Wiley.
- Lee, J. D. (2018). Concise Inorganic Chemistry (5th ed.). Wiley India Pvt. Ltd.
- Weller, M. T., Overton, T. L., Rourke, J. P., Armstrong, F. A., & Atkins, P. W. (2018). Inorganic Chemistry (7th ed.). Oxford University Press.

- Elias, A. (2024). Chemistry of the p-Block Elements: Syntheses, Reactions, and Applications (1st ed.). Universities Press.
- Housecroft, C. E., & Sharpe, A. G. (2023).Inorganic Chemistry (5th ed.). Pearson.
- Warren, S. C., & Walsh, P. J. (2024). Modern p-Block Chemistry (1st ed.). Wiley.
- Cotton, S. (2024). Lanthanide and Actinide Chemistry (2nd ed.). John Wiley & Sons.
- Rai, B. K., Bretana, A., Morrison, G., Greer, R., Gofryk, K., & zur Loye,H.-C. (2024). Crystal Structure and Magnetism of Actinide Oxides: A Review. arXiv.https://arxiv.org/abs/2403.01634

Online Resources & Tools:

SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 2		
Course Code **254510237004**	**Name of Course** **Inorganic Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: identify ions in inorganic mixtures by dry tests

CO-2: identify ions in inorganic mixtures by wet tests

Detailed Syllabus

Qualitative analysis of inorganic mixture (60h)

Semi-micro method of analysis of mixture of powders containing four radicals excluding soluble PO43-, arsenite, arsenate and borate. Mixture may be partly soluble in water and wholly soluble in an acid. Candidate should perform the analysis of following ions: Na^{+}, K^{+}, NH^{4+}, Mg^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Fe^{2+}, Fe^{3+} , Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Hg^{2+}, Pb^{2+}, Cu^{2+}, Sn^{2+}, Ag^{+} and $S^{2-,}$ SO_3^{2-}, SO_4^{2-}, CO_3^{2-}, Cl^{-}, Br^{-}, I^{-}, NO_3^{-}, NO_2^{-}

Mapping Matrix of POs, PSOs, and COs

	POs												PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	–	1	2	–	–	–	–	–	2.2	2	3	1	2
CO-2	3	3	3	–	–	1	2	–	–	–	–	–	2.4	2	3	1	2
Avg	3.0	2.5	3.0	–	–	1.0	2.0	–	–	–	–	–		2	3	1	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method

Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Kesavan, M. P. (2025). Inorganic Semi-Micro Qualitative Analysis. LAP Lambert Academic Publishing.
- Mukherjee, G. N. (2008). Semi-Micro Qualitative Inorganic Analysis. University of Calcutta Press.
- Vogel, A. I., & Svehla, G. (1979). Text-book of Macro and Semi-Micro Qualitative Inorganic Analysis (5th ed.). Longman.

Program – B.Sc. (Physics) Semester- 3		
Course Code **255010337005**	**Name of Course** **Organic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: state the concepts of stereochemistry and the mechanism of electrophilic substitution reactions

CO-2: describe the chemistry underlying the synthesis and behavior of amino acids, peptides, and proteins.

CO-3: identify aromatic and antiaromatic systems using delocalization and resonance criteria.

Detailed Syllabus

Unit-1 (A): Stereochemistry (8h)

1(A).1 Definition of stereochemistry and stereoisomerism **(0.5h)**

1(A).2 Configurational isomers: cis-trans isomers (for acyclic and cyclic compounds) **(0.5h)**

1(A).3 E-Z nomenclature **(1h)**

1(A).4 Chirality **(1h)**

1(A).5 Configurational isomers: isomers with one & more than one chiral centre (Lactic acid, Tartaric acid, 2,3-dibromopentane, 3-chloro-2-butanol): enantiomers, diastereomers, mesocompounds **(2h)**

1(A).6 R-S nomenclature (one and more than one chiral centre) **(2h)**

1(A).7 Conformational analysis of ethane and n-butane only **(1h)**

Unit-1 (B): Aromatic substitution reaction (7h)

1(B).1 Introduction about electrophilic and nucleophilic substitution reactions **(1h)**

1(B).2 Electrophilic reagent / electrophilic substitution reaction **(0.5h)**

1(B).3 Mechanism of nitration, sulphonation, halogenation, friedal craft alkylation, friedal craft acylation **(2h)**

1(B).4 Classification of substituents groups **(0.5h)**

1(B).5 Theory of orientation of second group in monosubstituted benzene [first substituent is activating / deactivating group] **(1h)**

1(B).6 Orientation of third group in disubstituted benzenes **(0.5h)**

1(B).7 Conversion [reactions form] based on above topics **(1.5h)**

Unit-2 Aminoacids, Peptides and Protein (15h)

2.1 General structure of aminoacids **(1h)**

2.2 Classification and nomenclature of amino acids**(1h)**

2.3 Configuration of amino acids: D and L notation **(1h)**

2.4 Preparation of amino acids: Amination of α-haloacids, Gabriel phthalamide synthesis, strecker synthesis **(2h)**

2.5 Zwitter ion (dipolar ion) **(1h)**

2.6 Isoelectric point of amino acids **(1h)**

2.7 Reaction of amino acid with ninhydrine (not structural reaction) **(1h)**

2.8 Peptide linkage (dipeptides, tripeptides, polypeptides) **(1h)**

2.9 Geometry of peptide linkages **(1h)**

2.10 Determination of structure of peptides **(2h)**

- N-terminal residue analysis (DNFB method, Phenyl isothiocynate method)
- C-terminal residue analysis(by thiohydantoin and with carboxypeptidase enzyme)

2.11Work out the sequence of amino acid residues from given peptides **(1h)**

2.12 The strategy of peptide synthesis (Benzyloxycarbonyl method) **(1h)**
2.13Overview of primary, secondary,tertiary and quternary structure of proteins **(1h)**

Unit-3 Electron delocalization, Resonance and Aromaticity (15h)

3.1 Delocalization electron and resonance **(1h)**
3.2 How to draw resonance contributors: rules for drawing resonance contributors (3h)
3.3 The resonance hybrid **(2h)**
3.4 Resonance energy **(1h)**
3.5 Stability of allylic and benzylic cations **(2h)**
3.6 Stability of allylic and benzylic radicals **(2h)**
3.7 Criteria for aromaticity **(1h)**
3.8 Aromaticity **(2h)**
3.9 Antiaromaticity **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	3	2	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	–	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	2	3	3	1	–	–	2	–	–	–	–	–	2.17	2	2	3	2.33
Avg	2.67	2.67	2.5	1.0	–	2.0	1.67	–	–	–	–	–		2.67	1.67	2.67	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

References

- Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2012). Organic chemistry (2nd ed.). Oxford University Press.
- Eliel, E. L., & Wilen, S.H. (1994). Stereochemistry of organic compounds (Rev. ed.). Wiley.
- Bruice, P. Y. (2024). ***Organic Chemistry*** (9th ed.). Pearson.

- Morrison, R. T., & Boyd, R. N. (2010). ***Organic Chemistry*** (7th ed.). Pearson Education India.
- Coppola, B. P. (2023). Structure and Reactivity: An Introduction to Organic Chemistry (2nd printing). Van-Griner Learning.
- McMurry, J. E. (2022). Organic Chemistry (9th ed.). OpenStax.https://openstax.org/details/books/organic-chemistry
- Ahluwalia, V. K., Kumar, L. S., & Kumar, S. (2022).Chemistry of natural products: amino acids, peptides, proteins and enzymes. Springer.
- Barrett, G. C., & Elmore, D. T. (2012). Amino acids and peptides: chemistry and analytical methods. Cambridge University Press.
- Garrett, R.H., & Grisham, C. M. (2024). Biochemistry (7th ed.). Cengage Learning.
- Carey, F. A., Giuliano, R. M., Allison, N., & Bane, S. (2023). Organic chemistry(12th International Student ed.). McGraw-Hill Education.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 3		
Course Code **255010337006**	**Name of Course** **Organic Chemistry Practical**	**Minor**
Credit: 03	**Teaching Scheme: Practical (90)**	**Teaching Hours: 90**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: demonstrate proficiency in performing qualitative analysis of organic compounds using standard laboratory techniques.

CO-2: apply appropriate methods and safety protocols to synthesize organic compounds effectively in a laboratory setting.

Detailed Syllabus

(A) Preparation of organic compounds and its confirmation by function group test and M.P (with mole ratio calculation) (30h)

(1) Oxidation: Benzoic acid from benzaldehyde by $KMnO_4$

(2) Nitration: p-nitroacetanilide from acetanilide

(3) Nitration: 1,3-dinitrobenzene from nitrobenzene

(B) Qualitative analysis of organic compounds (60h)

Candidates are expected to perform the following tests for the organic compounds

(1) Nature of compound: acidic, basic, phenolic, neutral based on solubility tests

(2) Presence of elements: Lassaigne's test (C,H, N,S,X)

(3) Identification of functional groups:

-COOH, >C=O

-OH (alcoholic), $-NH_2$

-OH (phenolic), $-NO_2$

$-CONH_2$

-CH, -X

(4) B.P. / M.P.

(5) Identification of compound

List of organic compounds for qualitative analysis

Compounds	Acidic	Basic	Phenolic	Neutral
C, H, O elements	Tartaric acid Citric acid Phthalic acid Benzoic acid Oxalic acid Succinic acid	-	Phenol α-Naphthol β-Naphthol Resorcinol	Methanol Ethanol Benzaldehyde Acetone Acetophenone Benzene Toluene Naphthalene
C, H, O, N elements	Anthranilic acid p-Nitrobenzoic acid	Aniline o-Nitroaniline m-Nitroaniline p-Nitroaniline α-Naphthylamine	o-Nitrophenol p-Nitrophenol	Acetamide Benzamide Nitrobenzene Urea
C, H, O, N, S elements	-	-	-	Thiourea
C, H, O, X elements	-	-	-	Chloroform Carbontetrachloride Chlorobenzene Bromobenzene

Mapping Matrix of POs, PSOs, and COs																
	POs												PSOs			
COs	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	2	3	1	3
CO-2	3	3	3	1	–	–	2	–	–	–	–	–	2.00	2	3	2	2.33
Avg	3.0	2.5	3.0	1.0	–	2.0	2.0	–	–	–	–	–		2	3	1.5	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy	
CO-1	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling
CO-2	Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling

Assessment Method			
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	20	Continuous Evaluation
	CO-2	20	
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**
	CO-1	30	Term End Examination
	CO-2	30	

References

- Vogel, A. I., Tatchell, A. R., Furniss, B. S.,Hannaford, A. J., & Smith, P. W. G. (1996). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Prentice Hall PTR.
- García-Isac-García, J., Dobado, J. A., Calvo-Flores, F. G., & Martínez-García,H (2015). Experimental Organic Chemistry: Laboratory Manual (3rd ed.). Academic Press.
- Liskin, D., Brunke, K., & Carney, J. (2023). Organic Chemistry Laboratory Manual (5th ed.). Kendall Hunt Higher Education.
- Singh, S. K. (2017). Lab manual of qualitative and quantitative analysis. Manakin Press.

Program – B.Sc. (Physics) Semester- 4		
Course Code **255010337007**	**Name of Course** **Organic Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: interpret ionic equilibrium in terms of acid-base reactions, pH scale, hydrolysis of salt and buffer systems.

CO-2: describe the relationship between physical properties and molecular structure

CO-3: recognize the catalytic processes and adsorption phenomena

Detailed Syllabus

Unit-1 Heterocyclic compounds (15h)

1.1 Introduction **(1h)**

1.2 Nomenclature of heterocycles: **(3h)**

-systematic nomenclature system for naming three to ten membered monocyclic hetero cycles of various unsaturation containing one or more hetero atoms

-system of nomenclature is based on the trivial and semitrivial names of heterocycles [Pyrrole, Furan, Thiophene, Selenophene, Pyrazole, Imidazole, Isoxazole, Pyridine, Pyridazine, Pyrimidine, Pyrazine, Pyrene, Indole, Isoindole, Purine, Quinoline, Isoquinoline]

-nomenclature systems for fused heterocycles

Five membered heterocyclic compounds [Pyrrole, Furan, Thiophene]

1.3 Source of pyrrole, furan and thiophene **(1h)**

1.4 Aromaticity and orbital structure of pyrrole,furan and thiophene **(1h)**

1.5 Preparation of pyrrole,furan and thiophene **(1h)**

1.6 Orientation of electrophilic substitution in pyrrole,furan and thiophene **(1h)**

1.7 Relative reactivity toward electrophilic aromatic substitution in pyrrole, furan, thiophene and benzene **(1h)**

Six membered heterocyclic compounds [Pyridine]

1.8 Source of pyridine compound **(1h)**

1.9 Aromaticity and orbital structure of pyridine **(1h)**

1.10 Basicity of pyridine including comparison with basicity of pyrroleand aliphatic amine **(1h)**

1.11 Orientation of electrophilic and nucleophilic substitution in pyridine **(2h)**

1.12 Relative reactivity toward electrophilic aromatic substitution in benzene, pyridine **(1h)**

Unit-2 Carbohydrates (15h)

2.1 Definition and classification **(0.5h)**

2.2 Nomenclature **(0.5h)**

2.3 D and L notation **(0.5h)**

2.4 Configuration of aldose and ketose containing three through six carbon atoms **(2h)**

2.5 General properties of monosaccharide (Glucose and Fructose): colour, taste, physical state, solubility **(0.5h)**

2.6 Chemical properties of monosaccharide (Glucose and Fructose): acetylation, oxidation, reduction, cynohydrin formation, oxime formation, osazone formation **(2.5h)**

2.7 Epimers, epimers of D-glucose, conversion of an aldohexose into its C-2 epimer (mannose) **(1h)**

2.8 Methods of interconversion of sugars **(2h)**

- Lengthening the carbon chain of aldoses (The Kiliani Fischer synthesis: aldohexose from aldopentose)
- Shortening the carbon chain of aldoses (The Ruff degradation: aldopentose from aldohexose)

2.9 Configuration of (+) glucose: The Fischer proof **(2h)**

2.10 Cyclic structure of glucose **(2h)**

2.11Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation **(1.5h)**

Unit-3 Chemical Reactivity and Molecular Structure (Acid-Base Properties) (15h)

3.1 Theories of acids and bases **(1h)**

3.2 pK_a scale: relation between ionization constant Ka (pKa) , K_b (pK_b) with strength of organic acids and bases**(2h)**

3.3 Inductive effect and strength of organic acids/ bases**(2h)**

3.4 Effect of resonance on strength of acids and bases **(3h)**

3.5 Effect of hybridization on acidity and basicity of organic acids/ bases **(2h)**

3.6 Role of steric effect on strength of organic acids/bases **(2h)**

3.7 Effect of hydrogen bond on strength of organic acids **(2h)**

3.8 Keto-enol tautomerism **(1h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	–	2	2	–	–	–	–	–	2.40	3	2	2	2.33
CO-2	3	2	2	–	–	2	1	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	3	3	2	1	–	–	1	–	–	–	–	–	2.00	3	2	2	2.33
Avg	3.0	2.33	2.33	1.0	–	2.0	1.33	–	–	–	–	–		3	1.67	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References

- Bruice, P. Y. (2024). Organic Chemistry (9th ed.). Pearson.
- Morrison, R. T., & Boyd, R. N. (2010). Organic Chemistry (7th ed.). Pearson Education IndiaClayden,
- J., Greeves, N., & Warren, S. (2012). Organic chemistry (2nd ed.). Oxford University Press.

- Joule, J. A., Mills, K., & Smith, G. (2010).Handbook of heterocyclic chemistry (3rd ed.). Elsevier.
- Pugh, A. (2021). Heterocyclic chemistry (1st ed.). University Press.
- Robyt, J. F. (1997). Essentials of carbohydrate chemistry (3rd ed.). Springer. https://doi.org/10.1007/978-1-4612-1622-3
- Sinnott, M. L. (2016). Carbohydrate chemistry and biochemistry: Structure and mechanism (2nd ed.). Royal Society of Chemistry.
- Smith, M. B. (2022). Organic chemistry: An acid–base approach (3rd ed.). CRC Press.
- Solomons, T. W. G., Fryhle, C. B., & Snyder, S. A. (2022). Organic chemistry (13th ed.). Wiley.

Online Resources & Tools:

- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Physics) Semester- 4		
Course Code **255010337008**	**Name of Course** **Analytical Chemistry**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: demonstrate foundational knowledge of Analytical Chemistry and its significance in chemical analysis.

CO-2: explain the principles and procedures of acid-base and complexometric titrations.

CO-3: apply statistical tools for the evaluation and interpretation of analytical data.

Detailed Syllabus

Unit-1 (A)Introduction of analytical chemistry (7h)

1(A).1 Role of analytical chemistry **(1h)**

1(A).2 Classification of analytical methods: chemical and instrumental methods **(1h)**

1(A).3 Advantages and limitations of chemical and instrumental methods **(3h)**

1(A).4 Literatures of analytical chemistry **(1h)**

1(A).5 Safety in analytical / chemistry laboratory **(1h)**

Unit-1 (B)Complexometric titrations (8h)

1(B).1 Introduction **(0.5h)**

1(B).2Classification of ligands **(0.5h)**

1(B).3 Structure and acidic properties of EDTA **(0.5h)**

1(B).4 Complexes and formation constant: how stable are complexes? **(1h)**

1(B).5 Effect of pH on EDTA equilibria**(1h)**

1(B).6 Types of EDTA titrations: direct titration, back titration, substitution titration **(1h)**

1(B).7 Indicators for EDTA titrations / metal ion indicators **(2h)**

- working mechanism
- Preliminary information of metal ion indicators- Murexide, Eriochrome black T, xylenol orange

1(B).8 Masking and demasking agents **(1.5h)**

Unit-2. Acid-base titrations (15h)

2.1 Introduction **(1h)**

2.2 Neutralization of strong acid with a strong base by pH metry **(2h)**

2.3 Neutralization of weak acid with a strong base by pH metry **(2h)**

2.4 Neutralization of weak base with a strong acid by pH metry **(2h)**

2.5 Titration of mixture of strong acid and weak acid / base by pH metry**(1h)**

2.6 Comparative study of different nature of curves for 2.2 to 2.5 **(1h)**

2.7 Acid-base indicators: definition, theory and Henderson-Hasselbach equation **(1h)**

2.8 Application of acid-base titrations **(2h)**

-Reagents for neutralization titrations: preparation and standardization of acids / bases

-The determination of inorganic substances (ammonium salts, nitrates and nitrites, carbonates and carbonate (mixtures)

-The determination of organic functional groups (carboxylic and sulphonic acid groups, amine groups, ester groups, hydroxyl groups (Phenolic), carbonyl groups)

2.9 Numerical based on 2.2 to 2.4, 2.7 **(3h)**

Unit-3. Statistics for analytical data (15h)

3.1 Limitation of analytical data **(0.5h)**

3.2 Accuracy and precision **(0.5h)**

3.3 Measurement of central tendency: mean, median and mode **(1h)**

3.4 Way of expressing accuracy: absolute error, relative error **(0.5h)**

3.5 Way of expressing precision: range, deviation, average deviation, relative average deviation, standard deviation, coefficient of variation, variance **(1h)**
3.6 Types of error in chemical analysis: systematic errors [instrumental error, errors of method, operative errors, personal errors] and random errors **(2h)**
3.7 The effect of systematic errors on analytical results: constant errors and proportional errors **(1h)**
3.8 Minimization of errors **(0.5h)**
3.9 Significant figure and computations **(1h)**
3.10 Confidence interval **(0.5h)**
3.11 Student's t-test: Are there difference in the methods? **(1h)**
-when accepted value is known
-comparison of the means of two samples
3.12 F-test: comparison of precision of two sets of data **(1h)**
3.13 Rejection of a result: the Q-test **(0.5h)**
3.14 Correlation coefficient: **(0.5h)**
- Pearson correlation coefficient
3.15 Linear regression **(0.5h)**
3.16 Numerical based on all topics **(3h)**

Mapping Matrix of POs, PSOs, and COs

	POs													PSOs			
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Avg**	**1**	**2**	**3**	**Avg**
CO-1	3	2	3	–	1	2	2	–	–	–	–	–	2.17	3	2	2	2.33
CO-2	3	2	3	–	–	1	2	–	–	–	–	–	2.20	3	3	2	2.67
CO-3	3	3	2	–	–	2	3	–	2	–	–	–	2.50	2	2	3	2.33
Avg	3.0	2.33	2.67	–	1.0	1.67	2.33	–	2.0	–	–	–		2.67	2.33	2.33	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

Teaching Pedagogy

CO-1 (Unit: 1)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-2 (Unit: 2)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity
CO-3 (Unit: 3)	Lecture using Black board, Presentations, Multimedia resources, Diagrams and Layouts, Group discussion and activity

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	13	10	3	-
	CO-2	13	10	3	
	CO-3	14	0	4	10
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	20	Term End Examination		
	CO-2	20			
	CO-3	20			

References
• Christian, G. D., Dasgupta, P. K., & Schug, K. A. (2020). Analytical chemistry (7th ed.). Wiley. • Harris, D. C. (2015). Quantitative chemical analysis (9th ed.). W.H Freeman. • Skoog, D. A., West, D. M.,Holler, F. J., & Crouch, S. R. (2021). Fundamentals of analytical chemistry (10th ed.). Cengage Learning • Vogel, A. I. (1991). Vogel's textbook of quantitative chemical analysis (5th ed.). Longman Scientific & Technical Publishing Group. • Day, R. A., Jr., & Underwood, A. L. (2015). Quantitative analysis (6th ed.). Pearson Education India. **Online Resources & Tools**: • SWAYAM Courses: https://swayam.gov.in

Program – B.Sc. (Physics) Semester- 4		
Course Code **255010237009**	**Name of Course** **Organic and Analytical Chemistry Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to:

CO-1: Perform systematic separation and qualitative analysis of components in organic mixtures using standard laboratory techniques.

CO-2: Execute EDTA titrations and pH-metric titrations with accuracy and adherence to analytical protocols.

Detailed Syllabus

(A) Qualitative analysis of organic mixture (28h)

Separation of two components from the mixture of organic compounds using semi-micro method, identification of compounds by lassaigne's test, functional group test, melting point / boiling point test

(1) Acids: Benzoic acid, Salicylicacid, Cinnamic acid, Phthalic acid, Anthranilic acid, Oxalic acid, Tartaric acid, p-nitrobenzoic acid

(2) Phenols: α-Naphthol, β-Naphthol, o-Nitrophenol, p-Nitrophenol, Resorcinol

(3) Amines: p-Toludine, o-Nitroaniline, m- Nitroaniline, p- Nitroaniline

(4) Neutral: Urea, Thiourea, Acetamide, Benzamide, Acetanilide, Glucose, Naphthalene

(B) EDTA titrations and pH metry titrations (32h)

(1) Determination of nickel: direct titration **(4h)**

(2) Determination of aluminium: back titration **(4h)**

(3) Determination of calcium: substitution titration **(4h)**

(4) Preparation of buffer solution from buffer tablets/various chemical mixtures **(4h)**

(5) Titration of HCl using standard solution of NaOH by pH metrically **(4h)**

(6) Titration of NaOH using standard solution of HCl by pH metrically **(4h)**

(7) Titration of CH_3COOH using standard solution of NaOH by pH metrically **(4h)**

(8) Titration of HCl + CH_3COOH using standard solution of NaOH by pH metrically **(4h)**

Mapping Matrix of POs, PSOs, and COs

COs	POs												PSOs				
	1	2	3	4	5	6	7	8	9	10	11	12	Avg	1	2	3	Avg
CO-1	2	2	3	-	-	-	2	-	-	2	-	1	2.00	2	3	1	2.00
CO-2	2	2	3	-	-	-	3	-	-	2	-	-	2.33	3	3	2	2.67
Avg	2	2	3	-	-	-	2.5	-	-	2	-	1		2.50	3.00	1.50	

3 = Strong Contribution, 2 = Moderate Contribution, 1 = Slight Contribution, --- = No Significant Contribution

<table>
<tr><th colspan="4">Teaching Pedagogy</th></tr>
<tr><td>CO-1</td><td colspan="3">Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling</td></tr>
<tr><td>CO-2</td><td colspan="3">Guided Inquiry-Based Learning, Collaborative Problem-Solving, Experiential Learning with Reflective Journaling</td></tr>
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<tr><td>CO-2</td><td>30</td></tr>
<tr><th colspan="4">References</th></tr>
<tr><td colspan="4">• Vogel, A. I., Tatchell, A. R., Furniss, B. S., Hannaford, A. J., & Smith, P. W. G. (1996). Vogel's Textbook of Practical Organic Chemistry (5th ed.). Prentice Hall PTR.
• Flaschka,H A. (2013). EDTA Titrations: An Introduction to Theory and Practice (2nd ed.). Elsevier.</td></tr>
</table>

MDC

AEC

VAC

SEC

Annexure-1

Multidisciplinary Course (MDC) (3 Courses x 3 Credits = Total 9 Credits)

(For semester 1 to 3)

Multi-Disciplinary Courses (MDC) (3 Courses x 3 Credits = Total 9 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Information, Communication and Media	Journalism	254510346801
2	Introduction to Commerce and Management	Commerce	254510358801
3	Social Science and Language	Gujarati	254510301801

Annexure-2

Ability Enhancement Course (AEC) (4 Courses x 2 Credits = Total 8 Credits)

(For semester 1 to 4)

Ability Enhancement Courses (AEC) (4 Courses x 2 Credits = Total 8 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	English for Communication	English	254510203601
2	Introduction to Gujarati Language	Gujarati	254510201601
3	Gujarati	Gujarati	254510201602
4	Hindi	Hindi	254510202601
5	Sanskrit	Bhartiya Bhasha Sanskriti Santhan	254510263601
6	Marathi	Bhartiya Bhasha Sanskriti Santhan	254510263602
7	Punjabi	Bhartiya Bhasha Sanskriti Santhan	254510263603
8	Malyalam	Bhartiya Bhasha Sanskriti Santhan	254510263604
9	Kannada	Bhartiya Bhasha Sanskriti Santhan	254510263605
10	Telugu	Bhartiya Bhasha Sanskriti Santhan	254510263606
11	Tamil	Bhartiya Bhasha Sanskriti Santhan	254510263607
12	Urdu	Bhartiya Bhasha Sanskriti Santhan	254510263608
13	Sindhi	Bhartiya Bhasha Sanskriti Santhan	254510263609
14	Bengali	Bhartiya Bhasha Sanskriti Santhan	254510263610
15	French	Bhartiya Bhasha Sanskriti Santhan	254510263611
16	Spanish	Bhartiya Bhasha Sanskriti Santhan	254510263612
17	German	Bhartiya Bhasha Sanskriti Santhan	254510263613
18	Chinese	Bhartiya Bhasha Sanskriti Santhan	254510263614
19	Japanese	Bhartiya Bhasha Sanskriti Santhan	254510263615
20	Russian	Bhartiya Bhasha Sanskriti Santhan	254510263616
21	Pali	Puratattva Mandir	254510264601
22	Prakrit	Puratattva Mandir	254510264602

Annexure-3

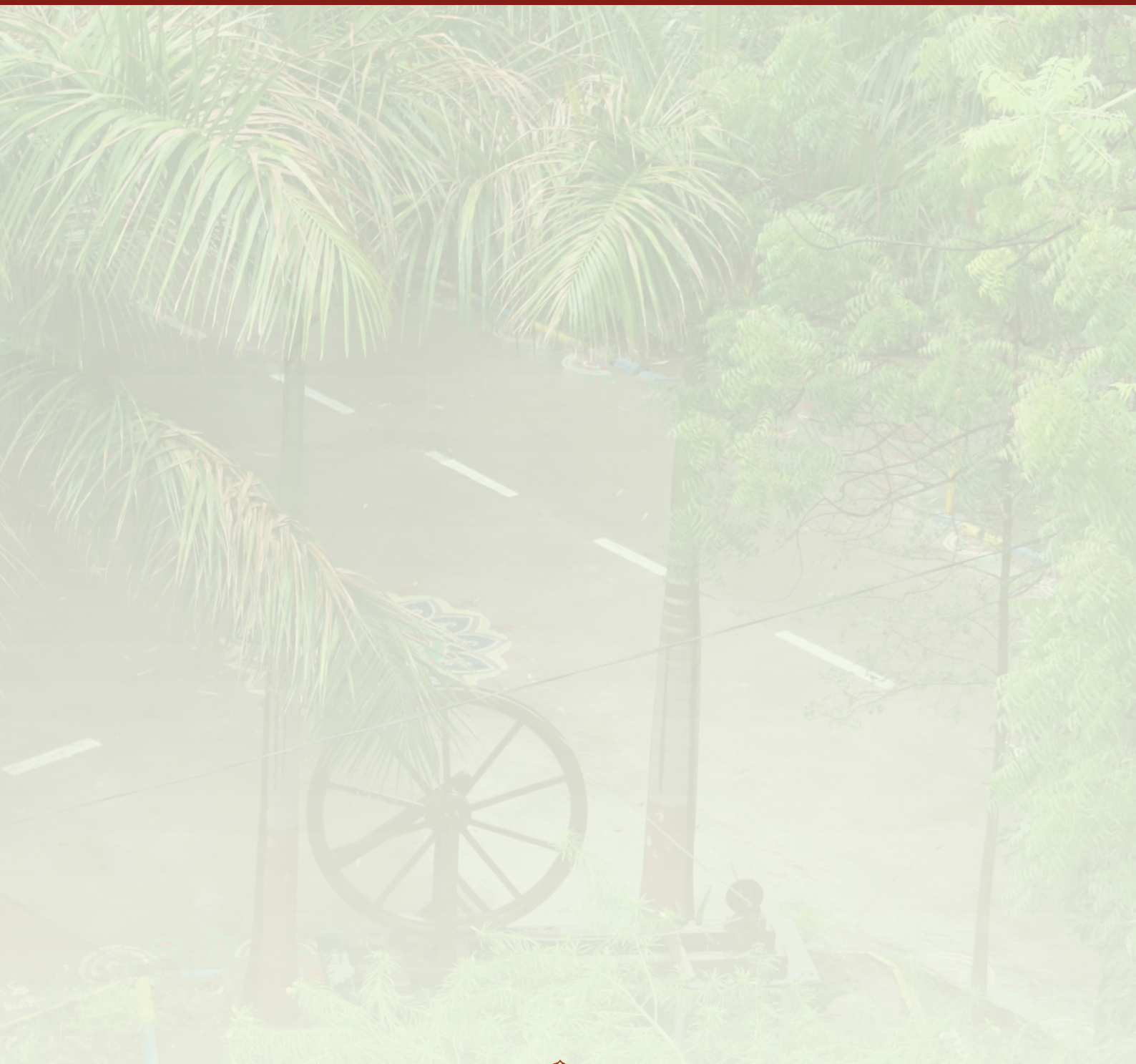
Value Added Course (VAC) (3 Courses x 2 Credits = Total 6 Credits) (For semester 1, 2 and 4)

Value Added Courses (VAC) (3 or 4 Courses x 2 Credits = Total 6 or 8 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Understanding India: History, Constitution, and Cultural Heritage	Puratattva Mandir	254510264701
2	Environmental Education	Microbiology	254510238701
3	Health, Yoga and Sports	Physical Education (Sports)	254510232701

Annexure-4

Skill Enhancement Course (SEC) (3 Courses x 3 Credits = Total 9 Credits) (For semester 1 to 3)

Skill Enhancement Courses (SEC) (3 Courses x 3 Credits = Total 9 Credits)			
No.	**Course**	**Department/Centre**	**Course Code**
1	Appreciation of Indian Classical Instrument – Harmonium	Kala Mandir	254510362901
2	Appreciation of Indian Classical Music – Tabla	Kala Mandir	254510362902
3	Appreciation of Indian Classical Dance – Kathak	Kala Mandir	254510362903
4	Appreciation of Indian Classical Dance – Bharatnatyam	Kala Mandir	254510362904
5	Appreciation of Indian Art – Elementary Drawing	Kala Mandir	254510362905
6	Appreciation of Indian Classical Music – Vocal	Kala Mandir	254510362906
7	Drawing and Painting	Kala Mandir	254510362907
8	Sculpture	Kala Mandir	254510362908
9	Spinning and Handicraft	Gandhian Studies	254510314901
10	Dress Making (Khadi Clothes)	VIKAS	254510361901
11	Embroidery Skills	VIKAS	254510361902
12	Solar PV Technician	VIKAS	254510361903
13	Electric Vehicle Technology	VIKAS	254510361904
14	Electronics Technician	VIKAS	254510361905
15	Horticulture	Rural Planning & Development	254510316901
16	Principles of Seed Production	Rural Planning & Development	254510316902
17	Seed Certification and Quality Testing	Rural Planning & Development	254510316903
18	3D Printing and Design	Computer Science	254510345901



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