Curriculum Framework

Bachelor of Science in Chemistry

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

(Chemistry)

As per NEP 2020 and Learning Outcomes-based National Curriculum Framework

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Effective From Academic Year 2025-2026

(Updated on 26-12-2025)

GUJARAT VIDYAPITH: AHMEDABAD

Curriculum Framework of Bachelor of Science (Chemistry)

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
(Chemistry)

Effective From Academic Year 2025-2026

(Updated on 26-12-2025)

Department of Microbiology

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, Chemistry Department, Ahmedabad.

Members from the Department:

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

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

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

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

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

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

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

PROGRAMME STRUCTURE							
Course Code	Course Name	H			Credit	Evaluations	
		Theory	Practical	Total		CCE	TEE
SEMESTER-1							
254510337001	Physical Chemistry	45	0	45	3	40	60
254510237002	Physical Chemistry Practical	0	60	60	2	40	60
254510338001 254510336001	Introduction to Microbial World OR Optics	45	0	45	3	40	60
254510238002 254510236002	Introduction to Microbial World Practical OR Physics 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							
254510337003	Inorganic Chemistry	45	0	45	3	40	60
254510237004	Inorganic Chemistry Practical	0	60	60	2	40	60
254510338003 254510336003	Basic Bacteriology OR Waves and Electronics	45	0	45	3	40	60
254510238004 254510236004	Basic Bacteriology Practical OR Physics 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							
255010337005	Organic Chemistry	45	0	45	3	40	60
255010337006	Organic Chemistry Practical	0	90	90	3	40	60
255010338005 255010336005	Microbial Physiology OR Solid State, Classical and Nuclear Chemistry	45	0	45	3	40	60
255010338006 255010336006	Microbial Physiology Practical OR Physics 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							
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
255010338007 255010336007	Microbial diversity OR Thermodynamics, Magnetostatics and Modern Physics	45	0	45	3	40	60
255010338008 255010336008	Applied Microbiology OR Basic Electronics	45	0	45	3	40	60
255010238009 255010236009	Microbial Biodiversity and Applied Microbiology Practical OR Physics 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**

SEMESTER-5							
255510337010	Organic Chemistry	45	0	45	3	40	60
255510337011	Inorganic Chemistry	45	0	45	3	40	60
255510337012	Physical Chemistry	45	0	45	3	40	60
255510537013	Chemistry Practical	0	150	150	5	40	60
255510437014	Internship	0	120	120	4	40	60
255510237015	Fuel Chemistry (Discipline Specific Elective)	30	0	30	2	40	60
255510237016	Polymer Chemistry (Discipline Specific Elective)						
255510237017	Inorganic Materials of Industrial Importance (Discipline Specific Elective)						
Total		**165**	**270**	**435**	**20**	**240**	**360**
SEMESTER-6							
255510337018	Organic Spectroscopy	45	0	45	3	40	60
255510237019	Organic Spectroscopy Practical	0	60	60	2	40	60
255510337020	Physical Chemistry	45	0	45	3	40	60
255510237021	Physical Chemistry Practical	0	60	60	2	40	60
255510337022	Nanotechnology and Greenchemistry	45	0	45	3	40	60
255510237023	Nanotechnology and Greenchemistry Practical	0	60	60	2	40	60
255510337024	Analytical Methods in Chemistry	45	0	45	3	40	60
255510237025	Analytical Methods in Chemistry 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 crteria: Bachelor of Science (B.Sc.)

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

Major and Minor subject

Sr.No	Major	Minor
1	Chemistry	Microbiology: G-1 /Physics: 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 Chemistry, a student will be able to:		
PSO Number	**Programme Specific Outcomes (PSOs)**	**Justification**
PSO1	Acquire foundational knowledge in key branches of chemistry—such as inorganic, organic, physical, analytical, and industrial—to solve problems, interpret chemical data, assess processes, and develop innovative, interdisciplinary solutions.	This PSO supports the development of discipline-specific knowledge (PO1) and problem analysis (PO2) while fostering an understanding of microbial roles in environmental sustainability (PO4).
PSO2	Develop and apply practical lab skills in techniques like titration, chromatography, spectroscopy, synthesis, and analysis; interpret results, assess method reliability, and refine protocols for improved outcomes.	This PSO is grounded in experimental skills (PO3), enhances familiarity with modern tools (PO7), and prepares students for basic project management (PO10) in scientific settings.
PSO3	Integrate core chemistry concepts with microbiology, physics, math, and environmental science to interpret phenomena, analyze complex problems, and develop innovative, real-world solutions through a multidisciplinary approach.	This outcome aligns with ethics and values (PO5), communication (PO6), teamwork (PO8), lifelong learning (PO9), and societal contribution (PO12) by fostering responsible citizenship and public**h)**ealth awareness.

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. (Chemistry) Semester- 1		
Course Code **254510337001**	**Name of Course** **Physical Chemistry**	**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: 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

	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		
	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.
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- 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. (Chemistry) Semester- 1		
Course Code **254510237002**	**Name of Course** **Physical Chemistry 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: 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. (Chemistry) Semester- 2		
Course Code **254510337003**	**Name of Course** **Inorganic Chemistry**	**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: 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,**h)**ydrogen and**h)**alogens **(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**h)**alogens) **(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,**h)**alogens 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**h)**alogens) **(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**h)**ydrogen, 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			

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- Lee, J. D. (2018). Concise Inorganic Chemistry (5th ed.). Wiley India Pvt. Ltd.
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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 2		
Course Code **254510237004**	**Name of Course** **Inorganic Chemistry 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: 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.
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Program – B.Sc. (Chemistry) Semester- 3		
Course Code **255010337005**	**Name of Course** **Organic Chemistry**	**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: 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

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- Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2012). Organic chemistry (2nd ed.). Oxford University Press.
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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 3		
Course Code **255010337006**	**Name of Course** **Organic Chemistry 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: 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.
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- Liskin, D., Brunke, K., & Carney, J. (2023). Organic Chemistry Laboratory Manual (5th ed.). Kendall Hunt Higher Education.
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Program – B.Sc. (Chemistry) Semester- 4		
Course Code **255010337007**	**Name of Course** **Organic Chemistry**	**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: 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

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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 4		
Course Code **255010337008**	**Name of Course** **Analytical Chemistry**	**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 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:**h)**ow 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		
	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

- 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. (Chemistry) Semester- 4		
Course Code **255010237009**	**Name of Course** **Organic and Analytical Chemistry 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: 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

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.
- Flaschka,H A. (2013). EDTA Titrations: An Introduction to Theory and Practice (2nd ed.). Elsevier.

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510337010**	**Name of Course** **Organic Chemistry**	**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 structure, synthesis, and reactivity of polynuclear aromatic hydrocarbons.

CO-2: describe the structural features and biological significance of selected pharmaceutical compounds.

CO-3: illustrate the synthesis and industrial applications of various classes of dyes.

Detailed Syllabus

Unit-1. Polynuclear Aromatic Hydrocarbons (15h)

1.1 Polynuclear Aromatic Compounds, Fused ring aromatic compounds, Nomenclature of naphthalene derivatives **(2h)**

1.2 Structure of naphthalene, Reactions of naphthalene, Oxidation of naphthalene, Reduction of naphthalene, Dehydrogenation of hydroaromatic compounds(Aromatization) **(2h)**

1.3 Nitration and halogenation of naphthalene, Orientation of electrophilic substitution in naphthalene, Friedal–Craft acylation of naphthalene, Sulphonation of naphthalene **(2h)**

1.4 Orientation of electrophilic substitution in naphthalene derivatives, Synthesis of naphthalene derivatives by ring closure (Haworth method). **(2h)**

1.5 Nomenclature of anthracene and phenanthrene derivatives **(1h)**

1.6 Structure of anthracene and phenanthrene, Reactions of anthracene and phenanthrene (2**h)**)

1.7 Preparation of anthracene derivative by ring closure. **(2h)**

1.8 Preparation of phenanthrene derivative by ring closure, Carcinogenic**h)**ydrocarbon. **(2h)**

Unit-2. Pharmaceutical Compounds: Structure and Importance (15h)

Classification, structure and therapeutic uses of…..

2.1 Antipyretics: Paracetamol (with synthesis) **(3h)**

2.2 Analgesics: Ibuprofen (with synthesis) **(3h)**

2.3 Antimalarials: Chloroquine (with synthesis) **(3h)**

2.4 An elementary treatment of Antibiotics and detailed study of chloramphenicol **(3h)**

2.5 Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine) **(3h)**

Unit-3. Dyes (15h)

3.1 Classification, Colour and constitution **(1h)**

3.2 Mordant and Vat Dyes; Chemistry of dyeing **(2h)**

Synthesis and applications of….(3.3 to 3.5)

3.3 Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling) **(3h)**

3.4 Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet **(3h)**

3.5 Phthalein Dyes – Phenolphthalein and Fluorescein **(3h)**

3.6 Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin **(2h)**

3.7 Edible Dyes with examples **(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	2	2	–	–	2	2	–	–	–	–	–	2.20	3	1	2	2.00
CO-2	3	2	2	1	2	2	–	–	–	–	–	–	2.00	3	1	3	2.33
CO-3	3	2	2	–	–	2	3	–	–	2	2	–	2.29	3	2	3	2.67
Avg	3.0	2.0	2.0	1.0	2.0	2.0	2.33	–	–	2.0	2.0	–		3	1.33	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

- Clayden, J., Greeves, N., & Warren, S. (2012). Organic Chemistry (2nd ed.). Oxford University Press.
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- Zollinger,H. (2003). Color chemistry: Syntheses, properties, and applications of organic dyes and pigments (3rd ed.). Wiley-VCH.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510337011**	**Name of Course** **Inorganic Chemistry**	**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 the physical properties and classifications of metals, semiconductors, and superconductors.

CO-2: analyze the role of metal ions in biological systems through concepts of bioinorganic chemistry.

CO-3: explain the bonding, structure, and reactivity of organometallic compounds

Detailed Syllabus

Unit-1 Metals, Semiconductors and Superconductors (15h)

1.1 Introduction **(1h)**

1.2 Properties of metallic solids. **(2h)**

1,3 Theories of bonding in metal. **(3h)**

i) Free electron theory.

ii) Molecular orbital theory (Band theory).

1.4 Classification of solids as conductor, insulators and semiconductors on the basis of band theory.**(2h)**

1.5 Semiconductors, Types of semiconductors - intrinsic and extrinsic semiconductors. **(2h)**

1.6 Applications of semiconductors. **(2h)**

1.7 Superconductors : Ceramic superconductors - Preparation and structures of mixed oxide $YBa_2Cu_3O_{7-x}$ **(2h)**

1.8 Applications of superconductors **(1h)**

Unit-2 Bio-inorganic Chemistry (15h)

2.1 Essentials and trace elements of life, ionophores and siderophores **(1h)**

2.2 Membrane transport (active and passive transport process) **(1h)**

2.3 Sodium / potassium-pump. **(1h)**

2.4 Excess and deficiency of some trace metals. **(1h)**

2.5Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity **(2h)**

2.6 Deficiency of Fe, Ca and iodine and consequences **(1h)**

2.7 Use of chelating agents in medicine (chelation therapy), platinum complexes as anticancer drugs. **(1h)**

2.8 Active site structure and functions of haemoglobin, myoglobin and role of iron and globin chain in haemoglobin **(2h)**

2.9 Active site structure of chlorophyll and role of magnesium and phytyl group in chlorophyll **(2h)**

2.10 Role of Co in vitamin B12. **(1h)**

2.11Metalloenzymes-Carbonicanhydrase, Carboxypeptidase **(1h)**

2.12 Hemocyanin-active site structures and functions **(1h)**

Unit-3 Organometallic Chemistry (15h)

3.1 Definition and classification of organometallic compounds, concept of hapticity. **(1h)**

3.2 18 & 16 electron rule, electron counts scheme. **(1h)**

3.3 Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. **(2h)**

3.4 π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and explanation of π -back bonding **(2h)**

3.5 Zeise's salt: Preparation and structure **(2h)**

3.6 Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation) **(2h)**

Study of the following catalytic processes and their mechanism:

3.7 Alkene Hydrogenation (Wilkinson's Catalyst) **(1h)**

3.8 Polymerisation of alkene (Ziegler–Natta Catalyst) **(1h)**

3.9 Hydroformylation (Co salts) **(1h)**

3.10 Wacker Process ($PdCl_2$) **(1h)**

3.11. Synthetic gasoline (Fischer Tropsch reaction) **(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	3	–	–	–	–	–	2.40	3	1	2	2.00
CO-2	3	2	2	2	2	–	–	–	–	–	–	–	2.20	3	1	3	2.33
CO-3	3	2	3	–	–	2	2	–	–	–	2	–	2.33	3	2	2	2.33
Avg	3.0	2.0	2.33	2.0	2.0	2.0	2.5	–	–	–	2.0	–		3	1.33	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

Continuous Comprehensive Evaluation 40 Marks			**Exam Component**		
	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

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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510337012**	**Name of Course** **Physical Chemistry**	**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: apply thermochemical principles, electrochemical concepts, and nuclear chemistry to solve chemical problems.

CO-2: understand the theoretical and practical aspects of electrochemical cells and electrode potentials.

CO-3: describe the principles and applications of nuclear reactions in chemistry.

Detailed Syllabus

Unit-1 Thermodynamics (15h)

First Law of Thermodynamics

1.1 Terminology of Thermodynamics, Work and heat, Internal Energy and First Law of Thermodynamics **(1h)**

1.2 Measurements of ΔE and ΔH,**h)**ess's Law and its applications,heat Capacity and Temperature dependence of ΔH **(1h)**

1.3 Numerical Problems. **(1h)**

Entropy And Second Law of Thermodynamics

1.4 Limitation of first law, spontaneous or irreversible process, cyclic process, Carnot cycle, Carnot theorem **(2h)**

1.5 Entropy the new state function, the concept of entropy, entropy change in isothermal expansion of an ideal gas **(2h)**

1.6 Entropy change in reversible and irreversible change, the entropy change accompanying phase change **(2h)**

1.7 Calculation of entropy of an ideal gas with change in P, V and T **(1h)**

1.8 Entropy of mixing of an ideal gas, physical significance of entropy **(2h)**

1.9 Work and free energy function, variation of free energy change with T and P **(1h)**

1.10 Numerical **(1h)**

Third law of thermodynamics

1.11 Third law of thermodynamics**(1h)**

Unit-2 Electrochemistry (15h)

2.1 Chemical cells, reversible and irreversible cells with examples **(2h)**

2.2 Electromotive force of a cell and its measurement, Nernst equation. **(2h)**

2.3 Standard electrode (reduction) potential and its application to different kinds of half-cells **(2h)**

2.4 Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone and glass electrodes. **(3h)**

2.5 Concentration cells with and without transference, liquid junction potential **(2h)**

2.6 Determination of activity coefficients and transference numbers. **(2h)**

2.7 Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation) **(2h)**

Unit-3 Nuclear Chemistry (15h)

3.1 Radioactivity, Types of radiations, Properties of radiations **(1h)**

3.2 Detection and measurementof radioactivity (Cloud Chamber, Ionisation Chamber, Geiger-Muller Counter, Scintillation Counter, Film Badges) **(2h)**

3.3 Types of radioactive decay, Rate of radioactive decay, Half-life **(2h)**

3.4 How to write nuclear equations **(1h)**

3.5 Radioactive dating**(1h)**

3.6 Mass defect, Nuclear binding energy, Neutron-proton ratio and nuclear stability **(2h)**

3.7 Nuclear fission process(Nuclear chain reaction) **(2h)**

3.8 Nuclear energy, Nuclear reactor, The atomic bomb **(2h)**

3.9 Nuclear fusion process, hydrogen bomb and fusion as a source of energy in 21st century **(2h)**

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	3	–	–	2	3	–	–	–	–	–	2.60	3	3	1	2.33
CO-3	3	2	–	2	2	–	–	–	–	–	–	2	2.20	3	2	2	2.33
Avg	3.0	2.3	2.5	2.0	2.0	2.0	2.5	–	–	–	2.0	2.0		3.00	2.33	1.67	

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

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- Ball, D. W. (2021). Physical chemistry (3rd ed.). Cengage Learning.
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- Levine, I. N. (2020). Physical chemistry (7th ed.). Pearson Education.
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- Choppin, G. R., Liljenzin, J. O., Rydberg, J., & Ekberg, C. (2021). Radiochemistry and nuclear chemistry (4th ed.). Academic Press.
- Meyer, G. J. (2022). Nuclear chemistry (2nd ed.). De Gruyter.
- Friedlander, G., Kennedy, J. W., Macias, E. S., & Miller, J. M. (2020). Nuclear and radiochemistry (4th ed.). Wiley-VCH.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510537013**	**Name of Course** **Chemistry 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: identify cations and anions in a given inorganic mixture containing six radicals using systematic qualitative analysis.

CO-2: estimate selected organic compounds using standard volumetric and gravimetric techniques.

CO-3: synthesize coordination compounds and interpret their chemical properties through experimental techniques.

Detailed Syllabus

(A) Qualitative analysis of inorganic mixture (80h)

Qualitative analysis of Inorganic mixture containing six radicals only.

The following radicals are suggested: 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^-

(B) Estimation (16h)

1. Estimation of glucose
2. Estimation of Oxalic acid by standardized NaOH
3. Estimation of vinegar by using standardized NaOH
4. Estimation of glycine by formal titration method (Soronsen's Method)

(C) Preparation of coordination compounds (54h)

1.Tris(thiourea)copper(I)sulphate,

2.Tetra ammine copper(II) sulphate,

3.Potash alum/ Chrome alum

4.Bis(dimethylglyoximinato)nickel(II),

5.Tris(acetylacetanoto)iron(III),

6.Potassium tri(oxalate)chromate(III)

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	–	–	–	–	–	2.5	2	3	1	2.00
CO-2	3	3	3	–	–	2	3	–	–	–	–	–	2.8	2	3	1	2.00
CO-3	3	3	3	2	–	–	2	–	–	–	2	–	2.5	3	3	2	2.67
Avg	3.0	2.7	3.0	2.0	–	2.0	2.3	–	–	–	2.0	–		2.33	3.00	1.33	

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

- Vogel's Qualitative Inorganic Analysis, 7th edition revised by Svehla, Pearson Education Pvt. Ltd (2004).
- Nordman, J. (2023). Qualitative testing and inorganic chemistry. Legare Street Press.
- Alhasan,H. S., & Alahmadi, N. (2021). Principles of qualitative inorganic analysis: Precipitation, separation and identification of cations. Bentham Books.
- Berry, A. J. (2016). Qualitative inorganic analysis (1st ed.). Cambridge University Press.
- Harris, D. C. (2015). Quantitative chemical analysis (9th ed.). W.H. Freeman.
- Kealey, D.& Haines, P. J. (2016). Analytical chemistry: Principles and techniques (2nd ed.). CRC Press.
- Li, N.,Hefferren, J. J., & Li, K. (2013). Quantitative chemical analysis. World Scientific.
- Vogel, A. I., Jeffery, G.H., Mendham, J., & Denney, R. C. (2019). Vogel's textbook of quantitative chemical analysis (6th ed.). Pearson Education.
- Buss, J. (Ed.). (2020). Inorganic Syntheses: Volume XVIII. University of Michigan Press.

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510437014**	**Name of Course** **Internship**	**Major**
Credit: 04	**Teaching Scheme: Practical (120)**	**Teaching Hours: 120**

Course Outcomes (COs)

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

CO-1: understand the workflow of Chemistry-related industries, labs, or research institutions.

CO-2: enhance professional skills like documentation, communication, discipline, and ethics.

CO-3: bridge the gap between theoretical knowledge and its practical application in Chemistry.

CO-4: provide practical exposure to chemical techniques in real-world settings.

About Internship

In-house as well as Institutional work carried out by students in the supervision of suitable guide. A bound copy of Internship report is necessary for evaluation.

- Student should develop an understanding about the workflow of Chemistry-related industries, labs or research institutions.
- Students should develop professional skills like documentation, communication, discipline, and ethics.
- The work undertaken should bridge the gap between theoretical knowledge and its practical application in Chemistry.

Stages of Internship course

Orientation and Induction, Laboratory/Field Training/Project Work / Case Study, Report Writing, Presentation & Viva.

Suggested Areas of Internship

Student should undertake work aligned with the any field of Chemistry to gain practical exposure to chemical techniques in real-world settings.

1. Industrial & Manufacturing Sectors
- Chemical manufacturing plants (fertilizers, dyes, paints, coatings)
- Petrochemical industries
- Cement and ceramics manufacturing units
- Soap, detergent, and cosmetics manufacturing

2. Pharmaceutical & Healthcare
- Pharmaceutical formulation and quality control labs
- Active pharmaceutical ingredient (API) manufacturing
- Clinical laboratories (pathology, biochemistry)
- Research and development (R&D) in drug discovery

3. Research & Development (R&D) Institutions
- CSIR laboratories (e.g., NCL, CDRI, IICT)
- Universities and research centers
- Food science and technology research labs

4. Environmental & Analytical Services
- Water quality testing labs
- Environmental monitoring agencies
- Pollution control boards
- Soil and agricultural chemistry analysis centers

5. Food & Beverage Industry
- Quality control labs in food processing industries
- Beverage and dairy product analysis
- Flavor and fragrance development units

6. Materials & Polymer Science
- Polymer and plastic manufacturing

- Rubber technology labs
- Paints and adhesives testing facilities

7. Forensic Science & Chemical Analysis

- Forensic science laboratories
- Toxicology labs
- Crime investigation units with chemical analysis sections

8. Energy & Sustainable Technology

- Biofuel production units
- Battery and solar cell research labs
- Green chemistry initiatives

Activities & Deliverables

- Maintain a daily work log
- Conduct experiments or observations
- Attend team meetings or field visits
- Submit a final internship report (10–15 pages)
- Give a presentation to internal faculty

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	

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. (Chemistry) Semester- 5		
Course Code **255510237015**	**Name of Course** **Fuel Chemistry**	**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 the chemical composition, classification, and industrial significance of coal.

CO-2: describe the origin, refining processes, and major applications of petroleum and petrochemicals

Detailed Syllabus

Unit-1. Coal (15h)

1.1 Review of energy sources (renewable and non-renewable). **(1h)**

1.2 Classification of fuels and their calorific value. **(2h)**

1.3 Uses of coal (fuel and nonfuel) in various industries, its composition **(2h)**

1.4 Carbonization of coal. **(2h)**

1.5 Coal gas, producer gas and water gas—composition and uses. **(2h)**

1.6 Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke **(2h)**

1.7 Coal gasification (Hydro gasification and Catalytic gasification) **(2h)**

1.8 Coal liquefaction and Solvent Refining. **(2h)**

Unit-2. Petroleum and Petrochemical (15h)

2.1 Composition of crude petroleum **(1h)**

2.2 Refining and different types of petroleum products and their applications. **(2h)**

2.3 Fractional Distillation (Principle and process) **(2h)**

2.4 Cracking (Thermal and catalytic cracking)**(1h)**

2.5 Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass) **(3h)**

2.6 fuel from waste **(2h)**

2.7 synthetic fuels (gaseous and liquids) **(2h)**

2.8 clean fuels **(2h)**

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	2	–	–	–	–	2	2.00	3	2	1	2.00
CO-2	3	3	–	3	–	2	2	–	–	–	2	2	2.43	3	2	2	2.33
Avg	3.0	2.5	–	2.5	–	1.5	2.0	–	–	–	2.0	2		3.0	2.0	1.5	

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

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

- Stocchi, E. (1990). Industrial chemistry (Vol. 1). Ellis Horwood Ltd.
- Jain, P. C., & Jain, M. (2023). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.
- Sharma, B. K. (2013). Industrial chemistry (17th ed.). Goel Publishing House.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510237016**	**Name of Course** **Polymer Chemistry**	**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: summarize the historical development and classification of polymeric materials.

CO-2: analyze the kinetics of polymerization and determine the molecular weights of polymers using appropriate techniques.

Detailed Syllabus

Unit-1 Introduction andh)istory of polymeric materials (15h)

1.1 Different schemes of classification of polymers **(1h)**

1.2 Polymer nomenclature **(1h)**

1.3 Molecular forces and chemical bonding in polymers **(2h)**

1.4 Texture of Polymers **(1h)**

1.5 Criteria for synthetic polymer formation **(2h)**

1.6 Classification of polymerization processes **(2h)**

1.7 Relationships between functionality **(2h)**

1.8 Extent of reaction and degree of polymerization. **(2h)**

1.9 Bifunctional systems **(1h)**

1.10 Poly-functional systems **(1h)**

Unit-2 Kinetics of Polymerization and molecular weight of polymers (15h)

2.1 Mechanism and kinetics of……

2.1.1 Step growth **(1h)**

2.1.2 Radical chain growth **(1h)**

2.1.3 Ionic chain (both cationic and anionic) **(1h)**

2.1.4 Coordination polymerizations **(1h)**

2.1.5 Copolymerization **(1h)**

2.2 Polymerization techniques. **(2h)**

2.3 Determination of molecular weight of polymers (Mn, Mw, etc) by …..

2.3.1 End group analysis **(1h)**

2.3.2 Viscometry **(1h)**

2.3.3 Light scattering and osmotic pressure methods **(2h)**

2.4 Molecular weight distribution and its significance **(2h)**

2.5 Polydispersity index. **(2h)**

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	2	2	–	–	–	–	2	2.00	3	1	2	2.00
CO-2	3	3	3	–	–	2	3	1	2	1	2	–	2.33	2	3	2	2.33
Avg	3.0	2.5	3.0	2.0	1.0	2.0	2.5	1.0	2.0	1.0	2.0	2.0		2.5	2.0	2.0	

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

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

- Seymour, R. B., & Carraher, C. E. (1981). *Polymer chemistry: An introduction*. Marcel Dekker.
- Ghosh, P. (1991). *Polymer science & technology*. Tata McGraw-Hill Education.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 5		
Course Code **255510237017**	**Name of Course** **Inorganic Materials of Industrial Importance**	**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: demonstrate understanding of raw materials, manufacturing processes, and uses of silicate-based industries.

CO-2: explain the types, components, and functioning of batteries and the role of fertilizers in agriculture.

Detailed Syllabus

Unit-1 Silicate Industries (15h)

Glass

1.1 Glassy state and its properties **(1h)**
1.2 Classification (silicate and non-silicate glasses) **(1h)**
1.3 Manufacture and processing of glass. **(1h)**
1.4 Composition and properties of the following types of glasses: **(4h)**
(a) Soda lime glass
(b) lead glass,
(c) armoured glass
(d) safety glass
(e) borosilicate glass
(f) fluorosilicate
(g) coloured glass
(h) photosensitive glass.

Ceramics

1.5 Important clays , feldspar, ceramic, their types and manufacture **(1h)**
1.6 High technology ceramics and their applications **(1h)**
1.7 Superconducting and semiconducting oxides **(1h)**
1.8 Fullerenes, carbon nanotubes and carbon fibre. **(1h)**

Cements

1.9 Classification of cement **(1h)**
1.10 Ingredients and their role **(1h)**
1.11 Manufacture of cement and the setting process**(1h)**
1.12 Quick setting cement **(1h)**

Unit-2 (A) Batteries (10h)

2.1 Primary and secondary batteries **(1h)**
2.2 battery components and their role **(1h)**
2.3 Characteristics of Battery. **(1h)**
2.4 Working of following batteries: Pb acid, Li-Battery, Solid state electrolyte battery. (4h)
2.5 Fuel cells **(1h)**
2.6 Solar cell **(1h)**
2.7 Polymer cell **(1h)**Bayes's theorem,

Unit-2 (B) Fertilizers (5h)

2.8 Types of fertilizers. **(1h)**
2.9 Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate. **(4h)**

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	2	–	–	–	1	2	2.00	3	2	2	2.33
CO-2	3	3	2	2	–	2	2	–	–	–	1	2	2.13	3	2	3	2.67
Avg	3.0	2.5	2.0	2.0	–	2.0	2.0	–	–	–	1.0	2.0		3.0	2.0	2.5	

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

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

- Kingery, W. D., Bowen,**h)**. K., & Uhlmann, D. R. (1976). Introduction to Ceramics (2nd ed.). Wiley.
- Felder, R. M., Rousseau, R. W., & Bullard, L. G. (2020). Elementary Principles of Chemical Processes (4th ed.). John Wiley & Sons..
- Kent, J. A. (Ed.). (2012). Riegel's Handbook of industrial chemistry (9th ed.). Springer Science & Business Media.
- Jain, P. C., & Jain, M. (2023). Engineering chemistry (17th ed.). Dhanpat Rai Publishing Company.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510337018**	**Name of Course** **Organic Spectroscopy**	**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:	predict λmax of conjugated systems and distinguish cis-trans isomers using UV-Visible spectroscopy.
CO-2:	dentify functional groups by analyzing IR absorption patterns and related spectral effects.
CO-3:	interpret proton NMR spectra to determine structures of simple organic compounds

Detailed Syllabus

Unit-1 UV Spectroscopy (15h)

1.1 Types of electronic transitions, λmax **(1h)**

1.2 Chromophores and Auxochromes **(2h)**

1.3 Bathochromic and hypsochromic shifts, Intensity of absorption **(2h)**

1.4 Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic,homoannular and heteroannular **(7h)**

1.5 Extended conjugated systems (aldehydes, ketones and dienes) **(2h)**

1.6 Distinction between cis and trans isomers. **(1h)**

Unit-2 IR Spectroscopy (15h)

2.1 Fundamental and non-fundamental molecular vibrations **(2h)**

2.2 IR absorption positions of O, N and S containing functional groups **(3h)**

2.3 Effect of H-bonding, conjugation, resonance and ring size on IR absorptions **(3h)**

2.4 Fingerprint region and its significance **(2h)**

2.5 Application in functional group analysis **(5h)**

Unit-3 NMR Spectroscopy (15h)

3.1 Basic principles of Proton Magnetic Resonance **(1h)**

3.2 chemical shift and factors influencing it **(2h)**

3.3 Spin – Spin coupling and coupling constant **(2h)**

3.4 Anisotropic effects in alkene, alkyne, aldehydes and aromatics **(2h)**

3.5 Interpetation of NMR spectra of simple compounds **(2h)**

3.6 Applications of IR, UV and NMR for identification of simple organic molecules **(6h)**

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	3	–	1	–	–	–	2.17	3	3	2	2.67
CO-2	3	2	2	–	–	2	3	–	–	–	–	–	2.33	3	3	2	2.67
CO-3	3	3	3	–	–	3	3	–	–	–	–	–	3.00	3	3	2	2.67
Avg	3.0	2.3	2.3	–	–	2.3	3.0	–	1.0	–	–	–		3.0	3.0	2.0	

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

- Kemp, W. (1993). Organic spectroscopy (3rd ed.). ELBS, Macmillan.
- Morrison, R. T., Boyd, R. N., & Bhattacharjee, S. K. (2011). Organic chemistry (7th ed.). Pearson Education Inc.
- Sharma, Y. R. (2013). Elementary organic spectroscopy: Principles and chemical applications (5th ed.). S. Chand Publishing.
- Kemp, W. (1986). NMR in chemistry: A multinuclear introduction. Macmillan.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510237019**	**Name of Course** **Organic Spectroscopy 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:	demonstrate the operation of UV, IR, and NMR instruments for organic compound analysis.
CO-2:	interpret IR and NMR spectra to identify simple organic compounds.

Detailed Syllabus

(A) Demonstration of UV, IR and NMR instruments (20h)

How to run instrument and how to analyze organic compound using UV, IR and NMR instruments will be demonstrated (This experiment will be conducted by visit of sophisticated instrumentation laboratory).

(B) Identification of simple organic compounds (40h)

Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).

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	3	–	–	–	–	–	2.33	3	3	2	2.67
CO-2	2	3	3	–	–	2	3	–	–	–	–	–	2.50	3	3	2	2.67
Avg	2.0	2.5	3.0	–	–	2.0	3.0	–	–	–	–	–		3.0	3.0	2.0	

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

- Kemp, W. (2022). Organic spectroscopy (3rd ed.). Bloomsbury Academic India.
- Pavia, D. L., Lampman, G. M., Kriz, G. S., & Vyvyan, J. R. (2015). Introduction to spectroscopy

(5th ed.). Cengage Learning.
- Yadav, L. D. S. (2015). Organic spectroscopy. Springer.
- Jagmohan. (2016). Organic spectroscopy: Principles and applications (2nd ed.). Narosa Publishing House.
- Dewan, S. K. (2010). Organic spectroscopy: NMR, IR, Mass, and UV. CBS Publishers & Distributors.

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510337020**	**Name of Course** **Physical Chemistry**	**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: apply photochemical laws to explain excited-state phenomena such as fluorescence and chemiluminescence.

CO-2: identify molecular symmetry elements and apply group theory concepts to classify point groups.

CO-3: apply rate laws and derive expressions for rate constants to study reaction kinetics and temperature dependence.

Detailed Syllabus

Unit-1 Photo chemistry (15h)

1.1 Introduction, Difference between thermal and photochemical processes. **(1h)**

1.2 Laws of photochemistry: Grotthus - Draper law, Lambert's law, Lambert Beer's law (with derivation), Stark - Einstein law. **(2h)**

1.3 Quantum yield, Reasons for High and low quantum yield. **(2h)**

1.4 Photosensitized reactions – Dissociation of H_2, Photosynthesis. **(2h)**

1.5 Photodimerisation of anthracene, decomposition of HI and HBr. **(2h)**

1.6 Jablonski diagram depicting various processes occurring in the excited state : Qualitative description of fluorescence and phosphorescence. **(2h)**

1.7 Chemiluminescence. **(1h)**

1.8 Numerical problems. **(3h)**

Unit-2 Group Theory (15h)

2.1 Symmetry and importance of symmetry aspects -Symmetry elements and various associated symmetry operations-Definitions and examples **(5h)**

2.2 Mathematical group – properties of a group – construction of group multiplication table (GMT) for H_2O and NH_3 – Abelian and non -Abelian groups-point groups- **(5h)**

2.3 Cnv, Cnh and Dnh- symmetry present with examples – matrix representation of symmetry operations E, Cn, σ, Sn and i. **(5h)**

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

3.1 The concept of reaction rates. **(1h)**

3.1 Effect of temperature, pressure, catalyst and other factors on reaction rates. **(1h)**

3.2 Order and molecularity of a reaction. **(1h)**

3.3 Derivation of first order rate constant **(2h)**

3.4 Derivation of Second order rate constant for (a=b) and ($a \neq b$). **(3h)**

3.5 Derivation of Third order rate constant (a=b=c) **(2h)**

3.6 Half–life of a reaction. **(2h)**

3.7 General methods for determination of order of a reaction. **(2h)**

3.8 Concept of activation energy and its calculation from Arrhenius equation. **(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	2	–	1	–	–	–	3	3	2	2	2.33
CO-2	3	3	–	–	–	2	2	–	2	–	–	–	3	3	1	2	2.00
CO-3	3	3	2	–	–	2	–	–	2	–	–	–	3	3	2	2	2.33
Avg	3.0	2.7	2.0	–	–	2.0	2.0	–	1.7	–	–	–	3.0	3.0	1.67	2.0	

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

- Rohatgi-Mukherjee, K. K. (2022). Fundamentals of photochemistry. New Age International Publishers.
- Atkinson, D. (2022). Photochemistry and photophysics. States Academic Press.
- Marazzi, M., & García Iriepa, C. (Eds.). (2023). Theoretical and computational photochemistry: Fundamentals, methods, applications and synergy with experimental approaches. Elsevier.
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- Raj, G., & Bhagi, A. (2010). Group theory and symmetry in chemistry. Krishna Prakashan Media.
- Atkins, P., & de Paula, J. (2022). Atkins' physical chemistry (12th ed.). Oxford University Press.
- Laidler, K. J. (2020). Chemical kinetics (3rd ed.). Pearson Education.
- Houston, P. L. (2021). Chemical kinetics and reaction dynamics (2nd ed.). Dover Publications.
- Espenson, J.H. (2019). Chemical kinetics and reaction mechanisms (2nd ed.). McGraw-Hill Education.
- Frost, A. A., & Pearson, R. G. (2018). Kinetics and mechanism (3rd ed.). Wiley.
- Barrow, G. M. (2007). Physical chemistry (6th ed.). Tata McGraw-Hill Education.
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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510237021**	**Name of Course** **Physical Chemistry 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: Acquire practical skills in conducting chemical kinetics experiments.

CO-2: Demonstrate understanding of photochemical reactions through laboratory experiments.

Detailed Syllabus

(A) Chemical Kinetics (40h)

1. The study of energy of activation of first order reaction i.e.hydrolysis of methyl acetate in presence of 0.5 N HCl / 0.5 N H_2SO_4.
2. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).
3. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).
4. To study the Hydrolysis of methyl acetate by using its two concentrations in presence of 0.5 N HCl and hence find velocity constant of the reaction.
5. To study the effect of addition of electrolyte (KCl) on the reaction between $K_2S_2O_8$ and KI (Equal concentrations).

(B) Photo chemistry (20h)

Demonstration of photochemistry related experiments

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	3	–	–	2	2	–	2	–	–	–	2.43	2	3	2	2.33
CO-2	3	2	3	–	–	2	2	–	2	–	–	–	2.29	2	3	2	2.33
Avg	3.0	2.5	3.0	–	–	2.0	2.0	–	2.0	–	–	–		2.0	3.0	2.0	

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

- Findlay, A. (1972). Findlay's practical physical chemistry (9th ed., B. P. Levitt, Ed.). Longman.
- Yadav, J. B. (2015). Advanced practical physical chemistry. Goel Publishing House.
- Khosla, B. D., Garg, V. C., & Gulati, A. (2018). Senior practical physical chemistry (18th ed.). R. Chand & Co
- Rajbhoj, A. S., & Chandekar, S. B. (2016). Systematic experimental physical chemistry. Anjali Publication.
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- Gurtu, J. N., & Gurtu, A. (2017). Advanced physical chemistry (4th ed.). Pragati Prakashan.

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510337022**	**Name of Course** **Nanotechnology and Green chemistry**	**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: identify various types of nanomaterials, explain their synthesis methods, and discuss their environmental applications.

CO-2: describe advanced characterization tools and interpret their role in analyzing nanomaterial properties.

CO-3: apply green chemistry principles to design sustainable chemical processes using eco-friendly techniques.

Detailed Syllabus

Unit-1 Nanomaterials and nanotechnology (15h)

1.1 Introduction **(1h)**

1.2 History of Nanomaterials **(2h)**

- 1.2.1 The Lycurgus cup
- 1.2.2 Michael Faraday's colloids
- 1.2.3 The story of the Damascus sword

1.3 Types of nanomaterials **(4h)**

- 1.3.1 One dimensional materials (Single or multi walled carbon nanotubes)
- 1.3.2 Two dimensional materials (nanofilms, nanosheets, Nanowalls)

1.4 Synthesis of nanomaterials **(4h)**

- 1.4.1 Top-down approach
- 1.4.2 Bottom-up approach

1.5 Environmental applications of nonmaterials **(4h)**

- 1.5.1 Nanomembranes in Drinking water treatment,
- 1.5.2 Nanomembranes in Sea desalination.
- 1.5.3 Nanomaterial in microfuelcell, fuel Cell, hydrogen storage.
- 1.5.4 Nanosensors

Unit-2 Characterization techniques for Nanomaterials (15h)

2.1 Particle size Analyser (Laser scattering) **(2h)**

2.2 Scanning Electron Microscopy (SEM) **(2h)**

2.3 Transmission Electron Microscopy (TEM) **(3h)**

2.4 Scanning Tunnel Microscopy (STM) **(2h)**

2.5 X-ray Diffraction (XRD) **(2h)**

2.6 2.6Auger Emission Spectroscopy**(2h)**

2.7 Electron Spectroscopy for Chemical analysis (ESCA) **(2h)**

Unit-3 Green Chemistry (15h)

3.1 Introduction **(1h)**

3.2 Basic principles (twelve) of green chemistry **(2h)**

3.3 Designing a green synthesis **(4h)**

- 3.3.1 Choice of starting materials
- 3.3.2 Choice of reagents
- 3.3.3 Choice of catalysts

3.3.4 Choice of solvents

3.4 Ultrasound assisted and Microwave assisted green synthesis **(2h)**

3.5 Biocatalysts in organic synthesis **(2h)**

3.5.1 Biochemical (Microbial) oxidations

3.5.2 Biochemical (Microbial) reductions

3.6 Aqueous phase reactions **(2h)**

3.6.1 Diels-Alder reaction

3.6.2 Epoxidation

3.6.3 Reduction of carbon-carbon double bonds

3.6.4 Synthesis of polycarbonates

3.7 Green chemistry in sustainable development **(2h)**

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	3	–	2	2	3	–	–	2	1	2	2	2.11	3	2	3	2.67
CO-2	2	2	3	–	3	3	3	2	1	–	1	3	2.30	3	3	2	2.67
CO-3	3	2	1	1	3	3	–	–	3	1	1	–	2.00	3	2	3	2.67
Avg	2.33	2.33	2.0	1.5	2.67	3.0	3.0	2.0	2.0	1.0	1.33	2.5					

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

- Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Guozhong Cao, Ying Wang,World Scientific (2011)
- Poole, C. P. Jr. and Owens F. J. Introduction to nanotechnology, Wiley India, New Delhi. (2009).

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- Anastas, P. T., & Warner, J. C. (2000). Green chemistry: Theory and practice. Oxford University Press.
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Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510237023**	**Name of Course** **Nanotechnology and Green chemistry 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 green chemistry principles to synthesize organic and coordination compounds using eco-friendly reagents and methods.

CO-2: Develop hands-on skills to synthesize and characterize nanomaterials using plant-based and sol-gel techniques.

Detailed Syllabus

(A) Greenchemistry (40h)

1. Preparation of acetanilide by using AcOH
2. Nitration of salicylic acid by green approach (using ceric ammonium nitrate)
3. Synthesis of azomethines from vanillin and 4-amino toluene
4. Preparation of Tris(acetylacetonato)manganese(III) by green method
5. Prepration of Tris(acetylacetonato)iron(III) by green method
6. Prepration of bis(acetylacetonato)copper(II) by green method
7. Preparation and use of green natural acid-base indicator

(B) Nanomaterials (20h)

1. Synthesis of plant based nano-materials and characterization **(10h)**
2. Sol gel method of synthesis of nano-material and characterization **(10h)**

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	3	3	2	2	–	2	–	3	3	2.45	3	2	3	2.67
CO-2	3	2	3	2	2	–	3	2	3	–	2	3	2.55	3	3	3	3.00
Avg	3.0	2.0	2.5	2.5	2.5	2.0	2.5	2.0	2.5	–	2.5	3.0		3.0	2.50	3.0	

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

- Green Chemistry Task Force Committee, DST. (2011). Monograph on green chemistry laboratory experiments. Department of Science & Technology, Government of India. Link
- Sharma, R. K., Sidhwani, I. T., & Chaudhuri, M. K. (2013). Green chemistry experiments: A monograph. I.K. International Publishing House.
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- Bandyopadhyay, A. K. (2010). Nano materials. New Age International Publishers.

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510337024**	**Name of Course** **Analytical Methods in Chemistry**	**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: apply principles of chromatography to separate and analyze chemical mixtures using techniques like TLC, paper, and column chromatography.

CO-2: interpret pH metric, potentiometric, and conductometric titration data for determining equivalence points and pKa values.

CO-3: demonstrate gravimetric procedures and perform quantitative calculations using classical precipitation methods.

Detailed Syllabus

Unit-1 Introduction to separation techniques (15h)

1.1 Filtration, distillation and solvent extraction **(2h)**
1.2 Chromatography: principle, classification of chromatographic methods **(2h)**
1.3 Paper chromatography: principle, experimental technique **(2h)**
1.4 Column chromatography: principle, experimental technique **(2h)**
1.5 Thin layer chromatography: principle, experimental technique **(2h)**
1.6 Ion exchange chromatography: principle, experimental technique **(1h)**
1.7 Gas chromatography: principle, experimental technique **(2h)**
1.8 Applications of chromatography in qualitative and quantitative analysis **(2h)**

Unit-2 Electroanalytical methods (15h)

2.1 Classification of electroanalytical methods **(2h)**
2.2 Basic principle of pH metric titrations **(2h)**
2.3 Basic principle of potentiometric titrations (3h)
2.4 Basic principle of conductometric titrations **(2h)**
2.5 Techniques used for the determination of equivalence points.(3h)
2.6 Techniques used for the determination of pKa values.(3h)

Unit-3 Gravimetric and Combustion analysis (15h)

3.1 Introduction **(1h)**
3.2 How to perform a successful gravimetric analysis?
- 3.2.1 Preparation of the solution **(1h)**
- 3.2.2 Precipitation **(1h)**
- 3.2.3 Digestion **(1h)**
- 3.2.4 Filtration **(1h)**
- 3.2.5 Washing **(1h)**
- 3.2.6 Drying or igniting **(1h)**
- 3.2.7 Weighing **(0.5h)**
- 3.2.8 Calculation **(0.5h)**

3.3 Gravimetric calculation:How much analyte is there? **(1h)**
3.4 Organic precipitants **(2h)**
- 3.4.1 Definition, only name and structure of three organic precipitants(Dimethylglyoxime, 8-hydroxyquinoline, Quinaldic acid), advantages and disadvantages of organic precipitants

3.5 Application of gravimetric analysis **(2h)**

3.6 Numericals based on 3.3 **(2h)**

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	–	–	–	–	–	2.60	2	3	2	2.33
CO-2	2	3	3	–	–	2	3	–	–	–	–	–	2.60	3	3	2	2.67
CO-3	2	2	3	–	–	2	2	–	–	–	–	–	2.17	3	3	2	2.67
Avg	2.33	2.33	3.00	–	–	2.00	2.67	–	–	–	–	–		2.67	3.0	2.0	

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

- Rouessac, F., Rouessac, A., & Towey, J. (2022). Chemical analysis: Modern instrumentation methods and techniques (3rd ed.). Wiley.
- Harris, D. C., & Lucy, C. A. (2020). Quantitative chemical analysis (10th ed.). W.H. Freeman.
- Skoog, D. A.,Holler, F. J., & Crouch, S. R. (2017). Principles of instrumental analysis (7th ed.). Cengage Learning.
- Poole, C. F. (2019). The essence of chromatography (2nd ed.). Elsevier.
- Skoog, D. A., West, D. M.,Holler, F. J., & Crouch, S. R. (2021). Fundamentals of analytical chemistry (10th ed.). Cengage Learning.
- Gilbert, J. C., & Martin, S. F. (2015). Experimental organic chemistry: A miniscale and microscale approach (6th ed.). Cengage Learning.
- Willard,H.H, Merritt, L. L., Dean, J. A., & Settle, F. A. (1988). Instrumental methods of analysis (7th ed.). Wadsworth Publishing Company.
- Christian, G. D., & Dasgupta, P. K. (2014). Analytical chemistry (7th ed.). Wiley.
- Miller, J. N., & Miller, J. C. (2010). Statistics and chemometrics for analytical chemistry (6th

ed.). Pearson Education.
- Dean, J. A. (1995). Analytical chemistry Handbook (2nd ed.). McGraw-Hill.

Online Resources & Tools:
- SWAYAM Courses**:** **https://swayam.gov.in**

Program – B.Sc. (Chemistry) Semester- 6		
Course Code **255510237025**	**Name of Course** **Analytical Methods in Chemistry 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 crystallization, distillation, and chromatography methods to purify and separate components in chemical mixtures.

CO-2: use conductometric titrations and gravimetric techniques for accurate quantitative chemical analysis.

Detailed Syllabus

(A) Separation techniques (16h)

1. Crystallizaton

- Concept of induction of crystallization
- Phthalic acid from hot water
- Acetanilide from boiling water
- Benzoic acid from water
- Naphthalene from ethanol

2. Distillation

- Simple distillation of acetone-water mixture using water condenser
- Distillation of nitrobenzene and chlorobenzene using air condenser
- Separation of azeotropic mixture

(3) Chromatography (Any three experiments)

- To separate Pb^{2+}, Ag^{+} and Hg^{2+}ions present in a mixture by paper chromatography
- To separate Zn^{2+}, $Pb^{2+}$and Cd^{2+}ions present in a mixture by paper chromatography
- Separation of a mixture of phenylalanine and glycine, alanine and aspartic acid, leucine and glutamic acid by paper and thin layer chromatography
- Separation of drug mixture by TLC

(B) Electroanalytical methods (12h)

Acid-base titrations by conductometrically

- HCl→NaOH
- NaOH→HCl
- CH_3COOH →NaOH
- HCl + CH_3COOH →NaOH

(C) Gravimetric Analysis (32h)

- **Iron as ironoxide**
- **Ni as Ni (DMG)$_2$**
- **Ba as $BaSO_4$**
- **Al as Al_2O_3**

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	1	–	2	3	–	1	–	–	1	2.00	2	3	2	2.33
CO-2	3	3	3	–	–	2	2	–	1	–	–	–	2.29	3	3	2	2.67
Avg	3.0	2.5	3.0	1.0	–	2.0	2.5	–	1.0	–	–	1.0		2.5	3.0	2.0	

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

- Kenkel, J. (2013). Analytical Chemistry for Technicians (4th ed.). CRC Press.
- Viswanathan, C., & Duraisamy, R. (2024). Analytical Chemistry Lab Manual. LAP LAMBERT Academic Publishing.
- Mikes, O., & Chalmers, R. A. (1979). Laboratory Handbook of chromatographic and allied methods. Ellis Horwood.

MINOR COURSE

(G1:Microbiology)

Program – B.Sc. (Chemistry) Semester- 1		
Course Code **254510338001**	**Name of Course** **Introduction to Microbial World**	**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: get an insight into the world of microorganisms.

CO-2: State the historical developments and major milestones leading to the development of microbiology as a separate discipline of science.

CO-3: acquire a broad perspective of the scope of microbiology

CO-4: be familiar with techniques like microscopy and staining procedures used to study microorganisms

Detailed Syllabus

Unit-1. Microbial World (11h)

1.1. Introduction: microbes in our lives **(1h)**

1.2. Distribution of microorganisms in nature **(1h)**

1.3. Introduction to taxonomy; Binomial system of nomenclature; Carl Woese's three domain, kingdom, Whittaker's five kingdom concept of classification **(2h)**

1.4. Major Groups of Microorganism; Difference between prokaryotic and eukaryotic microorganisms; Prokaryotic microbes: Eubacteria and Archeobacteria, Eukaryotic microbes: fungi (yeasts and molds), protozoa, algae; Acellular microbes: viruses **(3h)**

1.5. Introduction to methods of classifying Bacteria; Taxonomic groups (Taxa); The Goals of classification; A) Intuitive method, B) Numerical taxonomy, C) Genetic relatedness **(4h)**

Unit-2. History of Microbiology (12h)

2.1. The discovery of microorganisms; Microbiology and the origin of life; Contribution of A. V. Leeuwenhoek in the discovery of microscope; Spontaneous generation vs. Biogenesis **(5h)**

2.2. Golden age of microbiology; Germ theory of fermentation; Pure culture technique and Koch's Postulates; Contribution of Joseph Lister in Antisepsis; Contribution of Edward Jenner and Louis Pasteur in immunology; Birth of modern chemotherapy: contribution of Paul Ehrlich, Alexander Fleming and Selman A. Waksman **(7h)**

Unit-3. Scope and Relevance of Microbiology (11h)

3.1. Microbiology as a field of biology **(2h)**

3.2. Widening horizons; Medical microbiology; Agricultural microbiology: Contributions of Sergei N.Winogradsky and Martinus W. Beijerinck and development of enrichment culture technique; Public health microbiology; Microbial ecology; Food and dairy microbiology; Industrial microbiology **(5h)**

3.3. Microbiology and modern biology: molecular biology **(2h)**

3.4. Future of microbiology **(2h)**

Unit-4. Microscopy and Specimen Preparation (11h)

4.1. Light microscopy; Principle of bright-field microscopy: resolving power, numerical aperture, limit of resolution and magnification; Component parts of the compound light microscope; Principle, working and applications of dark-field, fluorescence, and phase-contrast microscopy **(4h)**

4.2. Preparation of specimens for light microscopy; Wet-mount and hanging-drop techniques; Microbiological stains: acidic, basic, and neutral dyes; Smear preparation, fixation, use of mordents, intensifiers, decolorizers; Simple staining of the smear: positive and negative staining **(4h)**

4.3. Electron microscopy: principle, working and applications of transmission and scanning electron microscopy **(3h)**

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	–	2	–	–	–	–	3	–	–	2	2.4	2.4	3	1	2
CO-2	3	2	1	2	3	–	–	–	3	–	–	2	2.3	2.3	2	1	1
CO-3	3	3	–	3	2	–	–	–	3	–	–	3	2.8	2.8	3	1	2
CO-4	2	3	3	2	–	–	–	–	3	–	–	2	2.5	2.5	2	3	2
Avg	2.8	2.5	2.0	2.3	2.5	–	–	–	3.0	–	–	2.3		2.5	1.5	1.8	

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

Teaching Pedagogy	
CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed., Indian ed.). Pearson India Education Services Pvt. Ltd.
2. Pelczar, J. R., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology* (5th ed.). McGraw-Hill Book Company.
3. Atlas, R. M. (2015). *Principles of microbiology* (2nd ed., Indian ed.). McGraw Hill Education (India) Private Limited.
4. Prescott, L., Harley, J. P., & Klein, D. A. (2019). *Microbiology* (11th ed.). Wm. C. Brown/McGraw-Hill.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 1		
Course Code **254510238002**	**Name of Course** **Introduction to Microbial World Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Analyze and apply proper sterilization, glassware preparation, aseptic techniques, and safety protocols (GLP)

CO2: Identify microorganisms through microscopic examination and staining techniques.

Detailed Syllabus

1) Microbiology Good Laboratory Practices (GLP): rules and safety **(2h)**
2) Introduction to size, shape, labeling (if required) and uses of laboratory glasswares/plastic wares: test tube, pipette, conical flask, volumetric flask, petri dish,measuring cylinder, coplin jar, burette, beaker, glass spreader **(5h)**
3) Cleaning and preparation of glassware for sterilization **(4h)**
4) Disposal of laboratory waste and cultures **(3h)**
5) Study of principle, component parts and operation of the compound light microscope **(3h)**
6) Study of principles and working of laboratory instruments: autoclave, hot airoven, incubator, water bath, bacteriological filters, centrifuge, rotary shaker, pH meter, colorimeter **(15h)**
7) pH adjustment of solution by use of pH strip and pH meter **(4h)**
8) Study of hay infusion by hanging drop method **(4h)**
9) Simple staining of bacteria: positive, curd (simple staining) and negative staining **(13h)**
10) Study of permanent slides/photomicrographs of different groups of microorganisms **(17h)**
    - **a)** Permanent slides of prokaryotic microbes (bacteria): Staphylococci, Bacilli, Spirochetes, Actinomycetes
    - **b)** Permanent slides of eukaryotic microbes:
        - Fungi: Yeast, Mucor, Penicillium
        - Algae: Diatoms, Spirogyra, Chlamydomonas
        - Protozoa: Amoeba, Paramecium, Euglena
    - **c)** Photomicrographs of acellular microbes (viruses): HIV, TMV, bacteriophage T2

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	3	2	3	–	3	2	2	–	–	2	2.6	2	2	2	2.0
CO-2	3	3	3	2	2	–	3	2	2	–	–	2	2.5	2	3	2	2.3
Avg	3	3.0	3.0	2.0	2.5	–	3.0	2.0	2.0	–	–	2.0		2	2.5	2	

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

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

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

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Chemistry) Semester- 2		
Course Code **254510338003**	**Name of Course** **Basic Bacteriology**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to….
CO1: examine and interpret the cellular organization and external structures of bacterial cell
CO2: explore and describe the cellular organization and internal structures of bacterial cell.
CO3: identify the nutritional needs of bacteria and evaluate various cultivation techniques of bacteria
CO4: apply methods to isolate and identify bacterial species from mixed cultures.

Detailed Syllabus

Unit-1. Cellular Organization and External Structures of Bacterial cell (11h)

1.1 Cellular organization: size, shape and arrangement of bacterial cells **(2.5h)**
1.2 External structures of bacterial cell **(2.5h)**
1.3 Structure and chemical composition of cell wall of Gram-positive and Gram-negative bacteria / Archaebacteria, Acid fast bacteria **(2h)**
1.4 Cell wall less bacteria, protoplast, spheroplast **(1h)**
1.5 Flagella of Gram-positive bacteria and Gram-negative bacteria , endo-flagella (axial filaments), bacterial motility **(1h)**
1.6 Capsules, slime layer, pili and fimbriae, sheaths, prosthecae and stalks **(2h)**

Unit-2. Internal Structures of Bacterial cell (12h)

2.1. Cytoplasmic membrane of Eubacteria and Archaebacteria **(2h)**
2.2. Structural differences between eubacteria and archaebacteria **(2h)**
2.3. Mesosomes **(0.5h)**
2.4. Cytoplasm and nuclear material (bacterialchromosome), bacterial plasmids **(1.5)**
2.5. Ribosomes of Eubacteria and Archaebacteria **(2h)**
2.6. Inclusion bodies (cellular reserve food materials) **(2h)**
2.7. Bacterial spores and cyst: spore structure, types of spores, sporogenesis and germination of spore, bacterial cyst **(2h)**

Unit-3. Nutrition and Cultivation of Bacteria (11h)

3.1. Nutritional and chemical requirements of bacteria: carbon, oxygen, nitrogen, sulfur, phosphorus, trace elements, vitamins, growth factors, water **(2h)**
3.2. Nutritional diversities in bacteria
- Based on source of energy: Phototrophs, Chemotrophs **(2h)**
- Based on source of electro donor: Lithotrophs, Organotrophs **(1.5h)**
- Based on source of carbon: Autotrophs, Heterotrophs, Mixotrophs, Obligate parasites **(1.5h)**

3.3. Culture media: media ingredients, preparation of media, general cultivation media (N.broth and N.agar) **(3h)**
3.4. Cultivation of anaerobic bacteria **(1h)**

Unit-4. Pure Culture Techniques (11h)

4.1. Pure culture, mixed culture, selective methods to obtain pure cultures: chemical, physical, and biological methods **(2.5h)**
4.2. Isolation methods of pure culture: aseptic technique , streak plate , spread plate and pour plate

techniques **(2.5h)**

4.3. Cultural characteristics: colony characteristics , characteristics of broth cultures **(2h)**

4.4. Maintenance and preservation of pure cultures **(2h)**

4.5. Culture collection centers and their role **(2h)**

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	2	1	2	1	1	2	2.4	3	2	2	2.0
CO-2	3	2	2	2	2	2	2	1	2	1	1	2	2.3	3	2	2	1.3
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.8	3	3	2	2.0
CO-4	3	3	3	2	2	2	3	2	2	2	2	2	2.5	3	3	2	2.3
Avg	3.0	3.0	2.5	2.0	2.0	2.0	2.5	1.3	2.0	1.5	1.5	2.0		**3.0**	**2.5**	**2.0**	

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

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	**COs**	**Marks**	**Written Test**	**Assignment/Seminar**	**Quiz/Discussion**
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Tortora, G. J., Funke, B. R., & Case, C. L. (2018). *Microbiology: An introduction* (13th ed., Indian ed.). Pearson India Education Services Pvt. Ltd.
2. Pelczar, J. R., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology* (5th ed.). McGraw-Hill Book Company.
3. Atlas, R. M. (2015). *Principles of microbiology* (2nd ed., Indian ed.). McGraw Hill Education (India) Private Limited.
4. Prescott, L., Harley, J. P., & Klein, D. A. (2019). *Microbiology* (11th ed.). Wm. C. Brown/McGraw-Hill.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 2		
Course Code **254510238004**	**Name of Course** **Basic Bacteriology Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Prepare, culture, and isolate bacterial strains using appropriate media and aseptic techniques

CO2: Demonstrate microbial identification and study structural/physiological traits through staining, pigment analysis, and environmental tolerance assays.

Detailed Syllabus

1) Preparation of bacteriological media: Nutrient broth and Nutrient agar **(5h)**

2) Cultivation and isolation of bacteria **(10h)**

- **a)** Broth culture method
- **b)** Agar plate methods: Streak plate method, Pour plate method, Spread plate method
  Method: Gram's stain of mixed bacterial culture, isolation of bacteria, colony (cultural) characteristics, morphological characteristics (Gram's stain)
- **c)** Agar slant (slope) method for pure culture

3) Cultivation of anaerobic bacteria by use of: a. Robertson's cooked meat media; b. Thioglycollate broth; Anaerobic jar (Demonstration) **(5h)**

4) Preservation of microbial cultures **(3h)**

- **a)** Periodic sub culturing and storage at refrigeration temperature
- **b)** Preservation of bacteria in soil (nitrogen fixers)

5) Study of pigmented bacteria **(5h)**

- **a)** *Staphylococcus aureus*
- **b)** *Staphylococcus epidermidis*
- **c)** *Micrococcus luteus*
- **d)** *Serratia marscescens*
- **e)** *Pseudomonas aeruginosa*

6) Differential staining of bacteria: Gram stain method **(7h)**

7) Study of bacterial structure by structural staining **(16h)**

- **a)** Endospore by Dorner's method
- **b)** Cell wall by Dyar's method
- **c)** Capsule by Hiss's method
- **d)** Granule by Albert's method

8) Use of special staining technique to study bacteria **(4h)**

- **a)** Spirocheates by Fontana's method

9) Study of effect of various physical agents on growth of bacteria **(5h)**

- **a)** Effect of pH
- **b)** Effect of temperature
- **c)** Effect of osmotic pressure (NaCl and Sucrose)
- **d)** Oligodynamic action of heavy metals

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	3	2	3	2	3	2	2	3	2	2	2.5	3	3	2	2.6
CO-2	3	3	3	2	2	2	3	2	2	2	2	2	2.3	3	3	2	2.6
Avg	3.0	3.0	3.0	2.0	2.5	2.0	3.0	2.0	2.0	2.5	2.0	2.0		3.0	3.0	2.0	

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

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

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

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Chemistry) Semester- 3		
Course Code **255010338005**	**Name of Course** **Microbial Physiology**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: examine essential nutrients for bacterial growth and various parameters affecting bacterial growth

CO2: explore enzyme classification, and the impact of various factors on enzyme activity

CO3: analyze bacterial growth phases and effects of antimicrobial agents on microbial populations

CO4: study structure and function of key biomolecules and their involvement in metabolic processes

Detailed Syllabus

Unit-1. Microbial Nutrition and Factors Affecting (11h)

1.1 Culture media: Types of culture media: Routine and specialized media; Selective media, differential media, enriched media, enrichment media, enumeration media, assay media and maintenance media **(4h)**

1.2 Modes of nutritional uptake **(4h)**

1.3 Classification of bacteria on the basis of growth supporting environmental factors such as oxygen, temperature, pH, osmotic pressure, salt and hydro static pressure **(3h)**

Unit-2. Enzymes (11h)

2.1. General introduction **(5h)**

a) Physical and chemical properties
b) Structure of enzymes: Prosthetic group, apoenzyme, coenzymes, cofactors
c) Localization of enzymes: Extra cellular and intra cellular
d) Nomenclature and classification of enzymes, lUB system of enzyme classification

2.2. Enzyme action **(6h)**

a) Active sites of enzymes
b) Mechanism of enzyme action
c) Factors affecting enzyme activity
d) Inhibition of enzyme activity: Competitive and non-competitive

Unit-3. Microbial growth (12h)

3.1. Methods of reproduction in bacteria and new cell formation **(3h)**

3.2. Growth **(5h)**

- Introduction to growth rate, generation time
- Criteria for growth measurement: Cell mass and cell number, methods of their measurement
- Normal growth curve of bacteria
- Continuous growth and synchronous growth

3.3. Chemotherapeutic agents as growth inhibitors **(4h)**

- Principles of chemotherapy
- General mode of action of various chemotherapeutic agents: Sulfonamides, antibiotics (penicillin, streptomycin, Polymixin)

Unit-4. Biomolecules and metabolism (11h)

4.1. Biomolecules: Chemical structure, properties, classification and biological significance of carbohydrates, proteins, lipids and nucleic acids **(6h)**

4.2. Introduction to metabolism: Anabolism, catabolism, primary and secondary metabolism, role of reducing power, precursor metabolites and energy rich compounds in cell Metabolism **(5h)**

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	2	1	2	1	1	2	2.4	3	2	2	2.0
CO-2	3	2	2	2	2	2	2	1	2	1	1	2	2.3	3	2	2	1.3
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.8	3	3	2	2.0
CO-4	3	3	3	2	2	2	3	2	2	2	2	2	2.5	3	3	2	2.3
Avg	3.0	3.0	2.5	2.0	2.0	2.0	2.5	1.3	2.0	1.5	1.5	2.0		**3.0**	**2.5**	**2.0**	

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

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
Continuous Comprehensive Evaluation 40 Marks	**CO-1**	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	**COs**	**Marks**	**Exam Component**		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Pelczar Jr, M J, Chan E C S., Krieg N R, (1986) Microbiology, 5th edn, McGraw-Hill Book Company, NY
2. Ingraham J L, and Ingraham, C L, (2000) Introduction to Microbiology, 2nd edn, Brooks/Cole, Singapore
3. Black J G, (2002) Microbiology: Principles and Explorations, 5th edn, John Wiley and Sons, Inc. NY

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 3		
Course Code **255010338006**	**Name of Course** **Microbial Physiology Practical**	**Minor**
Credit: 03	**Teaching Scheme: Practical (90)**	**Teaching Hours: 90**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Select, prepare, and utilize various microbiological media and perform qualitative biochemical and spectrophotometric analyses.

CO2: Assess microbial responses to antibiotics and nutrient substrates via antibiotic sensitivity assays and comprehensive biochemical reactions.

Detailed Syllabus

1) Study of different types of media and their ingredients: **(8h)**
   - **a)** Selective media: Rose Bengal agar medium
   - **b)** Differential media: Mac Conkey's medium, EMB agar medium, triple sugar iron agar medium
   - **c)** Enrichment media: Selenite broth
   - **d)** Enriched media: Blood agar medium, glucose yeast extract agar medium
   - **e)** Natural media: Soil extract agar, potato dextrose agar medium
2) Qualitative analysis of biomolecules: **(15h)**
   - **a)** Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed test, Bial's test and Saliwanoff s test
   - **b)** Proteins: Biurate test, Ehrlich's test, glyoxilic acid test, xanthoproteic test
3) Determination of absorption maxima of a colored solution (use methylene blue 1:20,000 dilution) **(15h)**
4) Study of effect of antibiotics on bacteria: **(15h)**
   - **a)** Study of sensitivity spectrum of antibiotic against the test organism by use of paper disc method
   - **b)** Determination of spectrum of activity of an antibiotic by use of agar ditch method
5) Study biochemical reaction of bacteria: **(37h)**
   - **A.** Based on carbon source
     - **i)** Oxidative and fermentative breakdown of glucose
     - **ii)** Fermentation of sugars and sugar alcohol: glucose, xylose, mannitol, lactose, maltose and sucrose
     - **iii)** Glucose breakdown product: Methyl red test, Voges-Proskauer's test
     - **iv)** Citrate utilization test
     - **v)** Citrate utilization test
     - **vi)** Lipid utilization test
   - **B.** Based on nitrogen source
   - **C.** Other tests- Catalase test, Dehydrogenase test, Oxidase test

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	3	2	3	2	3	2	2	2	2	2	2.5	3	3	2	2.6
CO-2	3	3	3	2	2	2	3	2	2	2	2	2	2.4	3	3	2	2.6
Avg	3	3	3	2	2.5	2	3	2	2	2	2	2		3	3	2	2.6

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

Teaching Pedagogy	
CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

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

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

Program – B.Sc. (Chemistry) Semester- 4		
Course Code **255010338007**	**Name of Course** **Microbial Diversity**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: explore the origins of microbial life examining the evolutionary processes that have led to the vast diversity of microorganisms on Earth

CO2: practical knowledge of different approaches to studying microbial diversity

CO3: investigate the diversity of prokaryotic life forms, focusing on the distinct characteristics and ecological roles of bacteria and archaea.

CO4: study the variety of eukaryotic microorganisms as well as acellular entities like viruses

Detailed Syllabus

Unit-1. Introduction (11h)

1.1 What is biodiversity? **(4h)**

1.2 Origin of life, evolution and origin of biodiversity, species concept, Evolutionary tree of microorganisms **(4h)**

1.3 Value of biodiversity, microbial biodiversity as index of environmental change **(3h)**

Unit-2. Methods ofAssessing Biodiversity (11h)

2.1. Microscopic methods **(3h)**

2.2. Cultural methods **(2h)**

2.3. Molecular and genomic methods: Molecular context of microbial diversity, importance of DNA and r RNA sequence comparison, determination of GC content **(6h)**

Unit-3. Biodiversity among Bacteria & Archaea (12h)

3.1. Morphological and cellular diversity **(4h)**

a) Diversity in major cell shape and grouping

b) Diversity in ultra structure of cell with reference to cell envelope, cell membrane, cell wall, surface appendages, other cell organelles and spore

3.2. Physiological and metabolic diversity- Diversity in photosynthetic, heterotrophic and autotrophic metabolism **(4h)**

3.3. Ecological diversity- Diversity in major ecosystems b. Diversity in aquatic, marine and extreme environment **(4h)**

Unit-4. Biodiversity among Eukaryotic and Acellular Microorganisms (11h)

4.1. Eucarya: Morphological, cellular, physiological, metabolic and ecological characteristicsof- Protozoans, Slime molds, Fungi, Algae, Lichens as consortium of algae and fungi **(6h)**

4.2. Acellular organisms: Viruses and prions **(5h)**

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	3	2	2	2	1	2	1	1	2	2.1	3	1	3	2.0
CO-2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	2	2	2	2.0
CO-3	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	2	3	2.6
CO-4	3	2	2	3	1	2	2	1	2	1	1	2	1.9	3	1	2	2.0
Avg	3	2.8	2.5	3.0	1.8	2.0	2.5	1.3	2.0	1.5	1.5	2.0		2.8	1.5	2.5	

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

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method

			Exam Component		
	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
Continuous Comprehensive Evaluation 40 Marks	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Atlas, R. M., & Bartha, R. (1998). *Microbial ecology: Fundamentals & applications* (4th ed.). Pearson Education.
2. Campbell, R. (1983). *Microbial ecology* (2nd ed.). Blackwell Scientific Publications.
3. Ogunseitan, O. (2005). *Microbial diversity: Form and function in prokaryotes*. Blackwell Publishing.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 4		
Course Code **255010338008**	**Name of Course** **Applied Microbiology**	**Minor**
Credit: 03	**Teaching Scheme: Theory (45)**	**Teaching Hours: 45**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: examine the role of soil microflora in nutrient cycling and their impact on soil health

CO2: analyze the microflora present in drinking water and evaluate wastewater management strategies.

CO3: investigate the microflora associated with foods, identify sources of contamination, assess factors affecting microbial growth, and explore spoilage mechanisms and preservation methods.

CO4: explore various fermented foods, evaluate food preservation techniques, assess foodborne diseases, and apply the principles of HACCP.

Detailed Syllabus

Unit-1. Microbiology of Soil (11h)

1.1 Physico-chemical characteristics of soil, soil microflora: Diversity in soil microflora **(2h)**

1.2 Methods of studying soilmicroflora: **(3h)**

- **i)** Direct microscopic method, agar plate technique, enrichment culture technique, and buried slide method
- **ii)** Use of Winogradsky column in studying microbial diversity in soil

1.3 Soil fertility: Role of microorganisms in soil fertility **(2h)**

1.4 Biogeochemical Cycles: **(4h)**

- **i)** Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
- **ii)** Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction
- **iii)** Phosphorus cycle: Phosphate immobilization and solubilisation

Unit-2. Microbiology of Drinking and Waste Water (11h)

2.1. Natural waters: Sources of contamination **(1h)**

2.2. Water-borne diseases **(2h)**

2.3. Purification of drinking water: Sedimentation, filtration and disinfection **(3h)**

2.4. Waste Management **(5h)**

- **i)** Types of wastewater, chemical and microbiological characteristics of waste water
- **ii)** Methods of waste water treatment:
  - **a)** Primary treatment and secondary treatment: Principles and role of microorganisms in septic tank, Imhoff tank, trickling filters, activated sludge process, oxidation ponds
  - **b)** Advanced treatment and final treatment
  - **c)** Solid waste processing: Anaerobic sludge digestion and composting

Unit-3. FOOD AND DAIRY MICROBIOLOGY -I (11h)

3.1. Foods as a substrate for microorganisms- Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general **(2h)**

3.2. Microbial spoilage of various foods- Principles, Spoilage of vegetables, fruits, meat, eggs, milk and canned foods **(4h)**

3.3. Principles and methods of food preservation: **(4h)**

- **i)** Physical methods: temperature (low, high), irradiation, and aseptic packaging
- **ii)** Chemical methods: salt, sugar, organic acids, SO_2, nitrite and nitrates, ethylene oxide, antibiotics

Unit-4. FOOD AND DAIRY MICROBIOLOGY -II (12h)

4.1. Fermented dairy products: **(4h)**

i) Dairy starter cultures

ii) fermented dairy products: yogurt, acidophilus milk, kefir, dahi and cheese

iii) Introduction to Probiotics, Prebiotics and Synbiotics

4.2. Indian fermented food products: Pickles, sauerkraut and bread **(2h)**

4.3. Microbes as food: Mushrooms, spirulina and yeasts **(2h)**

4.4. Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **(3h)**

i) Food intoxications: *Staphylococcus aureus, Clostridium botulinum*

ii) Food infections: *Bacillus cereus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni.*

4.5. HACCP **(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	3	2	2	2	1	2	1	1	2	2.0	3	2	3	2.6
CO-2	3	3	3	3	2	2	3	1	2	2	2	2	2.4	3	2	3	2.6
CO-3	3	3	3	2	2	2	3	1	2	2	2	2	2.3	3	2	3	2.6
CO-4	3	3	3	2	2	3	3	2	2	2	2	2	2.4	3	2	3	2.6
Avg	3	3	2.8	2.5	2.0	2.3	2.8	1.3	2.0	1.8	1.8	2.0		3.0	2.0	3.0	

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

Teaching Pedagogy

CO-1 (Unit: 1)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-2 (Unit: 2)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-3 (Unit: 3)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation
CO-4 (Unit: 4)	Direct teaching using black board and chalk, use of information communication technology, use of Internet, discussion, use of multimedia projector, power point presentation

Assessment Method					
			Exam Component		
Continuous Comprehensive Evaluation 40 Marks	COs	Marks	Written Test	Assignment/Seminar	Quiz/Discussion
	CO-1	10	10	--	--
	CO-2	10	10	--	--
	CO-3	10	0	5	5
	CO-4	10	0	5	5
Term-End Evaluation 60 Marks	COs	Marks	Exam Component		
	CO-1	15	Term End Examination		
	CO-2	15			
	CO-3	15			
	CO-4	15			

References

1. Alexander, M. (1977). *Soil microbiology* (2nd ed.). Krieger Publishing Co.
2. Atlas, R. M. (1997). *Principles of microbiology* (2nd ed.). Wm. C. Brown Publishers.
3. Frazier, W. C., & Westhoff, D. C. (1988). *Food microbiology* (4th ed.). McGraw-Hill Book Company.
4. Pelczar, M. J., Jr., Chan, E. C. S., & Krieg, N. R. (1986). *Microbiology* (5th ed.). McGraw-Hill Book Company.
5. Prescott, L., Harley, J. P., & Klein, D. A. (2008). *Microbiology* (7th ed.). Wm. C. Brown – McGraw-Hill.

Online Resources & Tools:

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

Program – B.Sc. (Chemistry) Semester- 4		
Course Code **255010238009**	**Name of Course** **Microbial Biodiversity and Applied Microbiology Practical**	**Minor**
Credit: 02	**Teaching Scheme: Practical (60)**	**Teaching Hours: 60**

Course Outcomes (COs)

After studying this course, the student will be able to….

CO1: Evaluate microbial diversity and adaptive capacities in extreme and natural environments through cultivation, morphological and biochemical characterization of diverse prokaryotic and eukaryotic microorganisms.

CO2: Perform comprehensive microbiological analyses of soil, water, food, and dairy products to assess microbial quality, identify pathogens, and understand microbial dynamics in various environments

Detailed Syllabus

1) Study of ecological diversity amongst bacteria at extreme conditions: Cultivation of acidotolerant (pH-4), alkalitolerant (pH-8), halotolerant (NaCl 10%), thermotolerant (temp:50 °C) bacteria [Cultivation using nutrient broth (as basal medium) at different environmental variable(s), results to be observed in form of turbidity followed by Gram's staining. Use routine nutrient broth as control tube. Soil sample to be used for cultivation] **(6h)**

2) Study of microbial diversity in soil by using Winogradsky Column (Demonstration only) **(1h)**

3) Study of morphological and cultural diversity of *Escherichia coli, Enterobacter aerogenes, Staphylococcus aureus, Bacillus subtilis, Bacillus megaterium and Bacillus cereus*.
Study of morphological diversity by performing Gram's staining, capsule staining and spore staining
Study of cultural / growth diversity using nutrient broth and nutrient agar media **(3h)**

4) Study of metabolic diversity amongst bacteria: *Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, Staphylococcus aureus, and Bacillus subtilis* by performing various biochemical tests: **(9h)**

Based on carbon metabolism

i) Methyl Red Test and Voges-Proskauer (V-P) test
ii) Fermentation of sugars and sugar alcohol: glucose, xylose, mannitol, lactose, maltose and sucrose
iii) Citrate utilization test
iv) Starch utilization test
v) Lipid utilization test

Based on nitrogen metabolism

i) Indole production test
ii) H_2S production test
iii) Urea utilization test
iv) Casein hydrolysis test
v) Gelatin hydrolysis test

Presence of respiratory enzymes

i) Catalasetest
ii) Dehydrogenase test
iii) Oxidase test

5) Study of diverse groups of eukaryotic microorganisms: **(3h)**
Fungi: Cultural and microscopic characters of Mucor, Rhizopus, Aspergillus, Penicillium andyeast
Algae: Study of algae present in pond water; study of permanent slides of spirogyra and diatoms
Protozoa: Study of presence of protozoa in pond water; study of permanent slides of Amoeba, Euglena and Paramecium

6) Microbiological analysis of soil: **(9h)**

Enumeration of organisms from soil (standard plate count from soil)
Isolation of symbiotic & non-symbiotic nitrogen fixing bacteria & actinomycetes from soil

7) Microbiological analysis of drinking water: **(9h)**
Standard plate count of drinking water
Detection of fecal pollution of water by performing presumptive test, confirmed test and completed test

8) Determination of MPN of coliforms in water **(2h)**

9) Microbiological analysis of Food: **(9h)**
Standard plate count of Food sample
Isolation of spoilage microorganisms from spoiled vegetables/fruits.
Isolation of spoilage microorganisms from bread

10) Microbiological analysis of milk: **(9h)**
- **i)** Standard plate count of milk sample
- **ii)** Determination of microbial load of milk by use of MBRT of raw milk, boiled milk and pasteurized milk.
- **iii)** Preparation of Yogurt/Dahi.
- **iv)** Detection of acid-fast organisms in milk sample

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	3	3	2	2	3	2	2	2	2	2	2.5	3	3	2	2.5
CO-2	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3	3	3	3.0
Avg	3	3	3	3	2	2	3	2	2	2	2	2	2.5	3.0	3.0	2.5	

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

Teaching Pedagogy

CO-1	Discussion, Experiments, Hands-on activities, Team work, Demonstration method
CO-2	Discussion, Experiments, Hands-on activities, Team work, Demonstration method

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

- Patel, Rakesh J. and Patel Kiran, R.,"Experimental Microbiology Vol. I and Vol. II". Aditya Prakashan, Ahmedabad. (2009).

MINOR COURSE (G2: Physics)

Program – B.Sc. (Chemistry) Semester- 1		
Course Code **254510336001**	**Name of Course** **Optics**	**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 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)

3.5. 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. (Chemistry)
Semester- 1

Course Code 254510236002	Name of Course PHYSICS 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: 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

(B) To determine the resolving power of prism.
(C) To determine Cauchy's constant A and B using a given formula and graph.
(D) To determine the resolving power of Plan Diffraction Grating.
(E) To determine the wavelength of sodium light using plane diffraction grating.
(F) To determine the resolving power of plane diffraction grating.
(G) Find out the refractive index of different liquids using convex lenses.
(H) LASER characteristics
(I) 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. (Chemistry) Semester- 2		
Course Code **254510336003**	**Name of Course** **Waves and Electronics**	**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:	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. (Chemistry)
Semester- 2

Course Code 254510236004	Name of Course PHYSICS 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: 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. (Chemistry) Semester- 3		
Course Code **255010336005**	**Name of Course** **Solid State, Classical and Nuclear Physics**	**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 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. (Chemistry)
Semester- 3

Course Code 255010336006	Name of Course PHYSICS 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: 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)

3.9 **Special Theory of Relativity**

  3.9.1 Postulates of special relativity. (with Michelson Morley experiment)
  3.9.2 Time dilation
  3.9.3 Doppler effect
  3.9.4 Length contraction

3.10 **Relativity of mass**
3.11 **Mass and energy**
3.12 **Lorentz transformation**
3.13 **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

Continuous Comprehensive Evaluation 40 Marks			**Exam Component**		
	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. (Chemistry)
Semester- 4

Course Code 255010236009	Name of Course PHYSICS 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: 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	
Term-End	**COs**	**Marks**	**Exam Component**

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

References

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

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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