SYLLABI AND SCHEME OF EXAMINATIONS FOR

(SKILL ENHANCEMENT COURSE FOR UNDER GRADUATE PROGRAM OFFERED BY THE DEPARTMENT OF CHEMISTRY)

B.Sc. (Life Sciences/Physical Sciences Program)

(Based on Curriculum and Credit Framework for UG Programs under NEP)

WITH EFFECT FROM THE SESSION 2024-25

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

SCHEME OF EXAMINATIONS FOR SKILL ENHANCEMENT COURSE OFFERED BY THE DEPARTMENT OF CHEMISTRY

B.Sc. (Life Sciences/Physical Sciences Program)

Skill Enhancement Course (SEC)	Nomenclature	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks				Total Marks
			L	T	P		L	T	P		Theory		Practical		
											Internal	External	Internal	External	
Semester I (Session 2024-25)															
SEC1 @ 3 credits	SECI-Role of Chemistry in Society	**24CHE401SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Chemistry Practical-I		0	0	1		0	0	2		---	---	05	20	
Semester II (Session 2024-25)															
SEC2 @ 3 credits	SECII-Fuel Chemistry	**24CHE402SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Chemistry Practical-II		0	0	1		0	0	2		---	---	05	20	
Semester III (Session 2025-26)															
SEC3 @ 3 credits	SECIII-Batteries	**25CHE403SE01**	2	0	0	**03**	2	0	0	**04**	15	35	---	---	**75**
	SEC Practical-III		0	0	1		0	0	2		---	---	05	20	
Semester VII (Session 2027-28)															
SEC5 @ 4 credits (if offered as an option)	Organic Chemistry Practical-I	**24CHE201SE01**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Semester VIII (Session 2027-28) Option-I															
SEC6 @ 4 credits (if offered as an option)	Organic Chemistry Practical-II	**24CHE202SE01**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**
Semester VIII (Session 2027-28) Option-II															
SEC6 @ 4 credits (if offered as an option)	Advanced Inorganic Chemistry Practical OR Advanced Physical Chemistry Practical OR Advanced Organic Chemistry Practical	**27CHE408SE01 OR 27CHE408SE02 OR 27CHE408SE03**	0	0	4	**04**	0	0	8	**08**	---	---	30	70	**100**

Syllabi for Skill Enhancement Course Offered by the Department of Chemistry for B.Sc. (Life Sciences/Physical Sciences Program)

Semester — I (Session: 2024- 25)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – I**	**Nomenclature**	**Role of Chemistry in Society**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE401SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Course Objectives: This course aims to provide a comprehensive understanding of analytical techniques in chemistry and environmental science. Students will learn soil and water analysis methods, including pH measurement, complexometric titrations and estimation of ions. Additionally, it covers the preparation and uses of various personal care products, introduction to pesticides and the principles behind fuel production and purification processes, emphasizing sustainability and environmental impact.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, students will be able to:

CLO1: Demonstrate proficiency in analysing soil and water samples, including pH measurement and estimation of ions.
CLO2: Handle analytical data.
CLO3: Learn basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products.
CLO4: Learn the use of safe, economic and body-friendly cosmetics.
CLO5: Gain knowledge of pesticides and their synthesis methods.
CLO6: Learn about the basic role of pesticide in everyday life, various ingredients and their role in controlling the pest.
CLO7: Introduce various measurement techniques used in different experiments including techniques for measuring pH, conductivity and electrode potential.
CLO8: Understand the concept of buffer solutions, their actions and measurement of their pH values.

Unit–I

Analysis of Soil and Water

Composition of soil, concept of pH and pH measurement of soil, complexometric titrations, chelation, chelating agents, use of indicators, estimation of calcium and magnesium ions in soil. Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods, determination of dissolved oxygen of a water sample.

Unit–II
Chemistry in Cosmetics A general study including preparation and uses of the following: Hair dye, soap, shampoo, suntan lotions, face powder, lipsticks, talcum powder, nail enamel.
Unit–III
Pesticides General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, brief introduction of structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: organochlorines (gammexene), organophosphates (malathion).
Unit–IV
Experimental Techniques Basic principle of pH metric, potentiometric and conductometric titrations, applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids and base, buffer solution, buffer action, Henderson–Hazel equation, buffer mechanism of buffer action.
Books Recommended/References:
1. Instrumental Methods of Analysis by D. A. Skoog, F. J. Holler and S. R. Crouch. 2. Chemistry In Daily Life by K. Singh. 3. General Chemistry Principles, Patterns, and Applications by B. Averill. 4. Engineering Chemistry by P. C. Jain and M. Jain. 5. Industrial Chemistry by B. K. Sharma. 6. Pesticides by R. J. Cremlyn. 7. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – I**	**Nomenclature**	**SEC Chemistry Practical – I**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE401SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Course Objectives: This course aims to make the students understand the colloidal solution, their preparation and principle of paper chromatography. It aims to build concepts related to the detection of sulphur in organic compounds as well as purity and purification methods for organic compounds.

***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Learn preparation of colloidal solution.

CLO2: Check the purity of compounds.

CLO3: Explore detection of sulphur.

CLO4: Learn about the purification methods of organic compounds.

CLO5: Gain a comprehensive understanding of the principles underlying crystallization.

CLO6: Understand the principle of paper chromatography.

List of Experiments
1. Preparation of colloidal solution of ferric hydroxide [$Fe(OH)_3$].
2. Check the purity of organic compounds. (By determination of melting and boiling points).
3. Detection of sulphur in organic compound by Nitroprusside test and Lead acetate test.
4. Purification of the organic compounds by crystallization (from water and alcohol) and distillation methods.
5. Separation of mixture of organic compounds by paper chromatography.
6. Separation of mixture of inks (blue, red and green) by paper chromatography.
Viva-Voce **(03 Marks)**
Note Book **(03 Marks)**
Books Recommended/References:
1. Laboratory Manual Chemistry of NCERT for class 11^{th} and 12^{th}. 2. Basic Concepts: Physical Chemistry Experiments by N. Seedher. 3. Senior Practical Physical Chemistry by B. D. Khosla. 4. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri. 5. Practical Organic Chemistry – A Primer by V. Peesapati. 6. Practical Organic Chemistry by A. K. Manna.

Semester — II (Session: 2024- 25)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – II**	**Nomenclature**	**Fuel Chemistry**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE402SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Course Objectives: This course provides an introduction to the chemistry of fuels, focusing on the composition, properties, combustion processes and environmental impacts of various types of fuels. Topics covered include solid fuels (such as coal), liquid fuels (such as crude oil, petroleum etc.), gaseous fuels (coal gas, natural gas and blast furnace gas), nuclear fuels, combustion chemistry, emissions control technologies, and sustainable energy solutions.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Define what constitutes a fuel and differentiate between different types of fuels.

CLO2: Understand the fundamental principles of fuel chemistry.

CLO3: Familiar with the processes involved in the production and refining of various fuels, including extraction, distillation, cracking, and blending.

CLO4: Apply thermodynamic principles to analyse combustion processes including calculating enthalpy changes, heat of combustion, and efficiency of combustion systems.

CLO5: Learn about the chemical composition, physical properties and characteristics of various fuels.

CLO6: Understand the importance of fuel quality standards and regulations.

CLO7: Determine safety protocols for handling, storing and transporting fuels.

CLO8: Analyse how fuel combustion activities affect ecosystems, human health, air quality and climate change.

Unit–I

Solid Fuels

Coal - origin, chemical composition, calorific value, classification, characteristics & distribution of Indian coals, storage and spontaneous combustion of coal, coal washing and blending, petrographic constituents of coal, carbonization of coal, manufacture and properties of metallurgical coke, recovery of by-products.

Unit–II

Liquid Fuels

Origin and composition of crude oil, crude oil distillation and its products with special reference to gasoline, kerosene and diesel oil, cracking and reforming, coal tar distillation products, shale oil.

Unit–III

Gaseous Fuels

Natural gas, coal gas, coke oven and blast furnace gas, manufacture of water gas and producer gas, carburetted water gas. Synthetic fuels: hydrogenation of coal, Fischer–Tropsch synthesis.

Unit–IV

Nuclear Fuels

Introduction, nuclear fuels and nuclear reactors, moderators and structural materials, introduction to renewable energy sources. Combustion: combustion of solids fuels, calculation of volume and weight of air necessary for combustion of fuels, gas analysis.

Books Recommended/References:

1. Fuels and Combustion by S. Sarkar.
2. Elements of Fuels, Furnaces & Refractories by O. P. Gupta.
3. The Elements of Fuel Technology by G. W. Himus and L. Hill.
4. Fuel: Solid, Liquid and Gaseous by J. S. S. Brame and J. G. King.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – II**	**Nomenclature**	**SEC Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE402SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**

Course Objectives: The course introduces the learner to prepare washing and liquid soaps, to check hardness, dissolved oxygen (DO) and chemical oxygen demand (COD) of water. This course also deals with analysis of saturation and unsaturation in organic compounds.

Note: Examiner will set two experiments for practical examinations. **(7×2) Marks**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Prepare soap by saponification.

CLO2: Understand the function of various ingredients used in soap-making.

CLO3: Check hardness of water by EDTA method.

CLO4: Detect unsaturation in organic compounds.

CLO5: Understand the chemical reactions of organic compounds with Br_2 water and Bayer's reagent.

CLO6: Determine DO and COD values in given water sample.

List of Experiments	
1. Preparation of washing soap from oils/fats. 2. Preparation of liquid soap from oils/fats. 3. To check hardness of water volumetrically by EDTA method. 4. To check saturation and unsaturation in organic compounds by Br_2 water and Bayer's reagent. 5. To determine DO and COD values in given water sample.	
Viva-Voce	**(03 Marks)**
Note Book	**(03 Marks)**
Books Recommended/References:	
1. Soap-Making Manual-A practical handbook on the raw materials, their manipulation, analysis and control in the modern soap plant by E. G. Thomssen. 2. Practical Chemistry by O. P. Pandey, D. N. Bajpai and S. Giri. 3. Practical Organic Chemistry by A. K. Manna. 4. Water Pollution Causes, Effects and Control by P. K. Goyal.	

Semester — III (Session: 2025- 26)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – III**	**Nomenclature**	**Batteries**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**25CHE403SE01**
Credits	**02**	**Maximum Marks**	**50**
Hours per Week	**02**	**External Marks**	**35**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**15**

Course Objectives: The aim of this paper is to make the students learn the basic principle, design, working of batteries and their applications in daily life. It includes comprehensive overview of general characteristics and applications of some primary and secondary batteries.

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing seven short answer type questions covering the entire syllabus. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:
CLO1: Define the fundamental components and operation principles of batteries.
CLO2: Describe the electrochemical reactions occurring in batteries.
CLO3: Identify potential safety problems in battery design and usage.
CLO4: Explain the principle of rechargeable battery design.
CLO5: Evaluate battery performance.
CLO6: Study battery materials.
CLO7: Explain the different types of batteries (primary and secondary) and their applications.
CLO8: Compare the construction techniques of various types of batteries.

Unit–I

Basic Concepts

Components of cells and batteries, classification of cells and batteries, operation of a cell, theoretical cell voltage, capacity, energy, specific energy and energy density of practical batteries.

Unit–II
Battery Design and Factors Affecting Battery Performance General introduction, designing to eliminate potential safety problems, battery safeguards when using discrete batteries, battery construction, design of rechargeable batteries, factors affecting battery performance.
Unit–III
Primary Batteries General characteristics and applications of primary batteries, types and characteristics of primary batteries, comparison of the performance characteristics of primary battery systems, recharging primary batteries. A) Zinc-Carbon Batteries (Leclanche´ and Zinc Chloride Cell Systems): General characteristics, cell chemistry, types of cells and batteries, construction, cell components. B) Magnesium and Aluminum Batteries: General characteristics, cell chemistry, construction of Mg/MnO_2 batteries, performance characteristics of Mg/MnO_2 batteries, sizes and types of Mg/MnO_2 batteries, other types of magnesium primary batteries.
Unit–IV
Secondary Batteries General characteristics and applications of secondary batteries, types and characteristics of secondary batteries, comparison of performance characteristics for secondary battery systems and introduction, chemistry, construction, performance characteristics, charging characteristics of following batteries: Lead batteries, Lithium ion batteries, Iron electrode batteries, Nickel-Cadmium, Nickel-Metal hydride, Nickel-Zinc batteries.
Books Recommended/References:
1. Understanding Batteries by R. M. Dell and D. A. J. 2. The TAB Battery Book: An In-Depth Guide to Construction, Design and Use by M. Root. 3. Fuel Cell- principles and applications by M. A. Scibioh and B. Vishwanathan. 4. Energy Storage Systems – Batteries and Their Chemistry by M. Cultu.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – III**	**Nomenclature**	**SEC Chemistry Practical – III**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**25CHE403SE01**
Credits	**01**	**Maximum Marks**	**25**
Hours per Week	**02**	**External Marks**	**20**
Duration of Examination	**02 Hrs.**	**Internal Marks**	**05**
Course Objectives: This course aims to provide knowledge of total dissolved solid (TDS) of water, retention factor (R_f value) of oil, estimation of iron from alloy and to detect aldehyde group. It also aims to enable student to identify the adulteration in given food materials.			
***Note: Examiner will set two experiments for practical examinations*.** **(7×2) Marks**			
Course Learning Outcomes (CLO): By the end of the course, the students will be able to: **CLO1:** Determine the TDS of given water sample. **CLO2:** Determine retention factor (R_f value) of oil. **CLO3:** Estimation of iron from alloy.			

CLO4: Explain the reactivity of aldehydes that allows them to be detected by specific tests. **CLO5:** Explain the redox reactions involved in Silver Mirror and Fehling's solution test. **CLO6:** Identify the adulteration in given food materials.
List of Experiments
1. Determination of TDS in a given water sample. 2. Determine retention factor (R_f value) of oil. 3. Estimation of iron from alloy. 4. Detection of aldehyde group by Silver Mirror test and Fehling's solution. 5. Checking the adulteration in given food materials (Milk, edible oil, sugar, turmeric and chilli powder).
Viva-Voce **(03 Marks)**
Note Book **(03 Marks)**
Books Recommended/References:
1. Water Treatment, How To Make Water Safe To Drink by D. Holman. 2. Organic Chemistry by S. N. Dhawan. 3. B.Sc. Chemistry Practical by S. Goyal. 4. Food Processing and Preservation by G. Subbulakshmi.

Semester — VII (Session: 2027- 28)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – V**	**Nomenclature**	**Organic Chemistry Practical – I**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE201SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: This course in organic chemistry focuses on qualitative analysis and simple organic preparations thereby providing the students with practical skills of separation, purification and identification of organic compounds. Through these objectives, students will acquire a well-rounded skill set that prepares them for further studies in organic chemistry and applications in various scientific and industrial contexts.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Handle organic chemicals in a safe and competent manner.
CLO2: Develop proficiency in basic laboratory techniques commonly used in organic chemistry.
CLO3: Develop an understanding on techniques like crystallization, melting point determination, boiling point determination along with the hands on experience.
CLO4: Understand the separation of organic compounds from binary mixtures.
CLO5: Develop the skills on the detection of extra elements in the unknown organic compound.
CLO6: Recognize different procedures for separation, identification and purification of organic compounds.
CLO7: Develop problem-solving skills to overcome obstacles encountered during laboratory work.

List of Experiments

1. **Qualitative Analysis** **(50 Marks)**
   Separation, purification and identification of organic compounds in binary mixtures by chemical tests and preparation of their derivatives.

Viva-Voce	**(10 Marks)**
Note Book	**(10 Marks)**

Books Recommended/References:

1. Experiments and Techniques in Organic chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton.
4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.
5. Vogel's Textbook of Practical Organic chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Semester — VIII (Session: 2027- 28)

(Option –I)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – VI**	**Nomenclature**	**Organic Chemistry Practical – II**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**24CHE202SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: The organic synthesis and purity analysis course aims to provide students with a complete understanding of organic synthesis techniques and the methods for assessing the purity of synthesized compounds. The course aims to prepare students for advanced work in organic chemistry, research or industrial applications by combining theoretical knowledge with practical skills in organic synthesis and analytical techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Handle organic chemicals in a safe and competent manner.
CLO2: Perform the standard techniques used in practical organic chemistry.
CLO3: Carry out multistep synthesis of organic compounds following a prescribed procedure.
CLO4: Apply the basic chemical concepts to understand the mechanism of chemical reactions.
CLO5: Characterize and purify the synthesized compounds.
CLO6: Determine melting point of the synthesized organic compounds.
CLO7: Monitor the chemical reactions and handle the chemicals safely.
CLO8: Calculate the yield and percentage yield of the chemical reactions.

List of Experiments

1. Simple organic preparations and checking the purity of samples prepared: (20 Marks)

(i) Chalcone from benzaldehyde and acetophenone.
(ii) Phenyl-azo-β-naphthol dye from aniline.
(iii) Adipic acid from cyclohexene.
(iv) 2-Butoxynaphthalene from 2-naphthol and 1-iodobutane.
(v) 3,4-Dihydropyrimidin-2(1H)-ones from aldehyde, β-ketoester and urea (Biginelli reaction).
(vi) Benzilic acid from benzil.

2. Two-step organic synthesis and checking purity of samples prepared: (30 Marks)

(i) Acetanilide from acetophenone *via* acetophenone oxime.

(ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide. (iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid. (iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene. (v) Anthranilic acid from phthalic anhydride *via* phthalimide. (vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene
Viva-Voce **(10 Marks)**
Note Book **(10 Marks)**
Books Recommended/References:
1. Experiments and Techniques in Organic Chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller. 2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath. 3. Systematic Qualitative Organic Analysis by H. Middleton. 4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark. 5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.

Semester — VIII (Session: 2027- 28)

(Option –II)

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**Chemistry Practical Paper – IX**	**Nomenclature**	**Advanced Inorganic Chemistry Practical**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE01**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: The course on quantitative inorganic analysis is designed to equip students with comprehensive knowledge and practical skills in separating and determining metal ions through various analytical methods. Additionally, students will delve into the principles and applications of cerimetry for determining Ferrous, Oxalate, and Nitrite ions. The course emphasizes hands-on experience in laboratory settings, ensuring proficiency in analytical techniques. Overall, the course aims to foster a deep understanding of inorganic analytical methods, enhance problem-solving skills, and promote awareness of sustainable practices in chemical analysis.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Separate and determine binary mixtures of metal ions using gravimetric and volumetric methods.
CLO2: Perform calculations involved in gravimetric analysis.
CLO3: Explain the principle underlying the gravimetric determinations.
CLO4: Determine strengths of ferrous and oxalate using cerimetry.
CLO5: Determine the strengths of nitrite ions using cerimetry (also by indirect method).
CLO6: Synthesize some metal acetylacetonato complexes employing green methods.
CLO7: Realise the importance of green technologies in sustainable growth of industry and society.
CLO8: Develop cleaner production and treatment mechanisms for pollution prevention.

List of Experiments
1. (a) Determination by Cerimetry **(25 Marks)** (i) Ferrous (ii) Oxalate (iii) Nitrite **(b) Green methods of preparation of the following** (i) Bis(acetylacetonato) zinc (II) (ii) Bis(acetylacetonato) chromium (II)
2. Quantitative Inorganic Analysis **(25 Marks)** **Separation and determination of two metal ions *via* volumetric and gravimetric methods** (i) Silver-Copper (ii) Copper-Nickel (iii) Copper-Zinc (iv) Nickel-Zinc (v) Copper-Iron (vi) Copper-Nickel (Both gravimetrically) (vii) Barium-Calcium (Both gravimetrically)
Viva-Voce **(10 Marks)**
Note Book **(10 Marks)**
Books Recommended/References:
1. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel. 2. Applied Analytical Chemistry by O.P. Vermani. 3. Vogel's Quantitative Chemical Analysis by J. Mendham. 4. Vogel's Qualitative Inorganic Analysis by G. Svehla. 5. Practical Inorganic Chemistry by Marr and Rockett. 6. Principles of Instrumental Analysis by D.A. Skoog, F.J. Holler and S.R. Crouch. 7. Quantitative Chemical Analysis by D.C. Harris.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**Chemistry Practical Paper – X**	**Nomenclature**	**Advanced Physical Chemistry Practical**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE02**
Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: The course on experimental techniques in physical chemistry aims to provide students with a thorough understanding of various experimental methods used in the study of physical chemistry principles. The objectives include developing hands-on experimental skills in physical chemistry techniques and enhancing the understanding of fundamental principles governing physical and chemical processes. This course aims to prepare students for advanced studies or careers in physical chemistry, research and industrial applications by combining theoretical knowledge with practical skills in experimental techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Know the concept of viscosity and determine the viscosity of various liquids.
CLO2: Compare the viscosity of various liquids.
CLO3: Study the conductometric and pH metric titration for determination of normality and strength of acids.

CLO4: Study the potentiometric titration of the given acids.
CLO5: Determine strength and thermodynamic properties of given acids.
CLO6: Determine the partition coefficient of a solute between two immiscible solvents using distribution law.
CLO7: Study the kinetics of hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.
CLO8: Develop the ability to compile interpreted information in the form of lab record.

List of Experiments

1. pH-metry **(25 Marks)**

(i) Titration of a mixture of (HCl + CH_3COOH) against NaOH pH-metrically and comment on the shape of the curve.

2. Viscosity

(i) Study the variation of viscosity with concentration for a glycerol/amyl alcohol solution using Ostwald viscometer and thereafter determine the concentration of unknown solution of glycerol and amyl alcohol.
(ii) Determination of molar mass of a polymer by using viscometer.
(iii) Determine the temperature coefficient of given liquid.

3. Distribution Law

(i) Study the complex formation of cuprammonium ion or study the complex formation between copper sulphate and ammonia solution.
(ii) Determination of equilibrium constant for $I_2 + I^- = I^-_3$

4. Conductometry **(25 Marks)**

(i) Study the equivalent conductance versus square root of concentration relationship of a strong electrolyte (KCl or NaCl) and weak electrolyte (acetic acid).
(ii) Determine the strength of NaOH and NH_4OH in a given mixture by titrating it against HCl.
(iii) Estimate conductometrically the quantities of HCl and NH_4Cl in their mixture.

5. Potentiometry

(i) Determine the strength of acetic acid by titrating it against NaOH potentiometrically. Also calculate dissociation constant of acid using quinhydrone electrode.
(ii) Study the effect of ionic strength on mean activity coefficient of HCl in a given solution.
(iii) Determine the standard free energy change and equilibrium constant for the reaction.

$$Cu + 2Ag^+ \longrightarrow Cu^{2+} + 2Ag$$

6. Chemical Kinetics

(i) Determination of the rate constant and activation energy for hydrolysis of ethyl or methyl acetate.
(ii) Determination of the temperature coefficient for hydrolysis of ethyl or methyl acetate and calculation of thermodynamic parameters.

Viva-Voce **(10 Marks)**

Note Book **(10 Marks)**

Books Recommended/References:

1. Practical Physical Chemistry by A. M. James and F. E. Prichard.
2. Findley's Practical Physical Chemistry by B. P. Lavitt.
3. Practical Physical Chemistry by S. R. Palit and S. K. De.
4. Experimental Physical Chemistry by R. C. Das and B. Behera.

Name of Program	**B.Sc. (Life Sciences/Physical Sciences)**	**Program Code**	**UMLS4 or UMPS4**
Paper No.	**SEC Paper – VI**	**Nomenclature**	**Advanced Organic Chemistry Practical**
Name of the Course	**Skill Enhancement Course**	**Course Code**	**27CHE408SE03**

Credits	**04**	**Maximum Marks**	**100**
Hours per Week	**08**	**External Marks**	**70**
Duration of Examination	**08 Hrs.**	**Internal Marks**	**30**

Course Objectives: The organic synthesis and purity analysis course aims to provide students with a complete understanding of organic synthesis techniques and the methods for assessing the purity of synthesized compounds. The course aims to prepare students for advanced work in organic chemistry, research or industrial applications by combining theoretical knowledge with practical skills in organic synthesis and analytical techniques.

***Note: Examiner will set two experiments for practical examinations*.**

Course Learning Outcomes (CLO): By the end of the course, the students will be able to:

CLO1: Handle organic chemicals in a safe and competent manner.
CLO2: Perform the standard techniques used in practical organic chemistry.
CLO3: Carry out multistep synthesis of organic compounds following a prescribed procedure.
CLO4: Apply the basic chemical concepts to understand the mechanism of chemical reactions.
CLO5: Characterize and purify the synthesized compounds.
CLO6: Determine melting point of the synthesized organic compounds.
CLO7: Monitor the chemical reactions and handle the chemicals safely.
CLO8: Calculate the yield and percentage yield of the chemical reactions.

List of Experiments

1. Simple organic preparations and checking the purity of samples prepared: (20 Marks)

(i) Chalcone from benzaldehyde and acetophenone.
(ii) Phenyl-azo-β-naphthol dye from aniline.
(iii) Adipic acid from cyclohexene.
(iv) 2-Butoxynaphthalene from 2-naphthol and 1-iodobutane.
(v) 3,4-Dihydropyrimidin-2(1H)-ones from aldehyde, β-ketoester and urea (Biginelli reaction).
(vi) Benzilic acid from benzil.

2. Two-step organic synthesis and checking purity of samples prepared: (30 Marks)

(i) Acetanilide from acetophenone *via* acetophenone oxime.
(ii) *p*-Nitroaniline from acetanilide *via p*-nitroacetanilide.
(iii) Methyl orange from sulphanilic acid *via* diazotized sulphanilic acid.
(iv) 2,4-Dinitrophenylhydrazine from chlorobenzene *via* 1-chloro-2,4-dinitrobenzene.
(v) Anthranilic acid from phthalic anhydride *via* phthalimide.
(vi) *m*-Nitroaniline from nitrobenzene *via m*-dinitrobenzene

Viva-Voce (10 Marks)

Note Book (10 Marks)

Books Recommended/References:

1. Experiments and Techniques in Organic Chemistry by D. J. Pasto, C. R. Johnson and M. J. Miller.
2. Macroscale and Microscale Organic Experiments by K. L. Williamson and D. C. Heath.
3. Systematic Qualitative Organic Analysis by H. Middleton.
4. A Handbook of Organic Analysis-Qualitative and Quantitative by H. Clark.
5. Vogel's Textbook of Practical Organic Chemistry by A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hanaford and P. W. G. Smith.