

Department of Chemistry

B.Sc Physical Sciences

SCHEME UG AI: UNDERGRADUATE PROGRAMME (MULTIDISCIPLINARY)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A1	Chemistry-I		3		2	3		1	4	25	50	5	20	100

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
			Core Course(s)											
CC-A2	Chemistry-II		3		2	3		1	4	25	50	5	20	100

Semester 3

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A3	Chemistry-III		3		2	3		1	4	25	50	5	20	100

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A4	Chemistry-IV		3		2	3		1	4	25	50	5	20	100

Semester 5

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A5	Chemistry-V		3		2	3		1	4	25	50	5	20	100

Internship is to be done during summer break after 4th Semester, Marks will be added in 5th Semester.

Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A6	Chemistry-VI		3		2	3		1	4	25	50	5	20	100

The curriculum of semester 7 and 8 will be provided in due course of time.

Department of Chemistry
B.Sc Physical Sciences
SCHEME UG A2: UNDERGRADUATE PROGRAMME (SINGLE MAJOR)

Semester 1

Course Code		Course Title	Course ID	L	T	P	L	T	P	Total Credits	MARKS				
				(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)															
CC-A1		Inorganic Chemistry-I		3		2	3		1	4	25	50	5	20	100
CC-A2		Organic Chemistry-I		3		2	3		1	4	25	50	5	20	100
CC-A3		Physical Chemistry-I		3		2	3		1	4	25	50	5	20	100
Minor/ Vocational Course(s)															
MIC-1		One from Pool		2			2			2	15	35			50
Multidisciplinary Course(s)															
MDC-1		One from Pool		2		2	2		1	3	15	35	5	20	75
Ability Enhancement Course(s)															
AEC-1		One from Pool		2			2			2	15	35			50
Skill Enhancement Course(s)															
SEC-1		One from Pool		2		2	2		1	3	15	35	5	20	75
Value-added Course(s)															
VAC-1		One from Pool								2					50
Total Credits										24					600
Semester 2															

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS					
			(Hrs)			Credits				TI	TE	PI	PE	Total	
Core Course(s)															
CC-A4	Inorganic Chemistry-II		3		2	3		1	4	25	50	5	20	100	
CC-A5	Organic Chemistry-II		3		2	3		1	4	25	50	5	20	100	
CC-A6	Physical Chemistry-II		3		2	3		1	4	25	50	5	20	100	
Minor/ Vocational Course(s)															
MIC-2	One from Pool		2			2			2	15	35			50	
Multidisciplinary Course(s)															
MDC-2	One from Pool		2		2	2		1	3	15	35	5	20	75	
Ability Enhancement Course(s)															
AEC-2	One from Pool		2			2			2	15	35			50	
Skill Enhancement Course(s)															
SEC-2	One from Pool		2		2	2		1	3	15	35	5	20	75	
Value-added Course(s)															
VAC-2	One from Pool								2					50	

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Total Credits											24						600
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Semester 3

Course Code	Course Title	Course-ID	L	T	P	L	T	P	Credits	MARKS					
			(Hrs)			Credits				TI	TE	PI	PE	Total	
Core Course(s)															
CC-A7	Inorganic Chemistry-III		3		2	3		1	4	25	50	5	20	100	
CC-A8	Organic Chemistry-III		3		2	3		1	4	25	50	5	20	100	
CC-A9	Physical Chemistry-III		3		2	3		1	4	25	50	5	20	100	
Minor/ Vocational Course(s)															
MIC-3	One from Pool		3		2	3		1	4	25	50	5	20	100	
Multidisciplinary Course(s)															
MDC-3	One from Pool		2		2	2		1	3	15	35	5	20	75	
Skill Enhancement Course(s)															
SEC-3	One from Pool		2		2	2		1	3	15	35	5	20	75	
Total Credits									22					550	

Semester 4

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS					
			(Hrs)			Credits				TI	TE	PI	PE	Total	
Core Course(s)															
CC-A10	Inorganic Chemistry-IV		3		2	3		1	4	25	50	5	20	100	
CC-A11	Organic Chemistry-IV		3		2	3		1	4	25	50	5	20	100	
CC-A12	Physical Chemistry-IV		3		2	3		1	4	25	50	5	20	100	
Minor/ Vocational Course(s)															
MIC-4	One from Pool		3		2	3		1	4	25	50	5	20	100	
Ability Enhancement Course(s)															
AEC-4	One from Pool		2			2			2	15	35			50	
Value-added Course(s)															
VAC-3	One from Pool		2			2			2	15	35			50	
Total Credits									20					500	

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Semester 5

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A13	Inorganic Chemistry-V		3		2	3		1	4	25	50	5	20	100
CC-A14	Organic Chemistry-V		3		2	3		1	4	25	50	5	20	100
CC-A15	Physical Chemistry-V		3		2	3		1	4	25	50	5	20	100
Minor/ Vocational Course(s)														
VOC-1	One from Pool		3		2	3		1	4	25	50	5	20	100
Skill Enhancement Course(s)														
Internship									4					100
Total Credits									20					500

Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
Core Course(s)														
CC-A16	Inorganic Chemistry-VI		3		2	3		1	4	25	50	5	20	100
CC-A17	Organic Chemistry-VI		3		2	3		1	4	25	50	5	20	100
CC-A18	Physical Chemistry-VI		3		2	3		1	4	25	50	5	20	100
Minor/ Vocational Course(s)														
MIC-6	One from Pool		3		2	3		1	4	25	50	5	20	100
MIC-7	One from Pool		3		2	3		1	4	25	50	5	20	100
Ability Enhancement Course(s)														
AEC-3	One from Pool		2			2			2	15	35			50
Total Credits									22					550

**The curriculum of semester 7 and 8 will be provided in due course of time.*

Department of Chemistry
B.Sc Physical Sciences

ABILITY ENHANCEMENT COURSE FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY

(These courses are offered by department of Indian and Foreign Languages for students of other departments/same department and leads to enhancement in the ability of learn Regional and foreign languages)

Semester 1

Semester I														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-1	English Language and Communication: Level-1 OR हिंदी भाषा एव. सम्प्रेषण-1 OR संस्कृत भाषा एव. सम्प्रेषण-1								2					50

Semester 2

Semester 2														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-2	English Language and Communication: Level-2 OR हिंदी भाषा एव. सम्प्रेषण-2 OR संस्कृत भाषा एव. सम्प्रेषण-2								2					50

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Semester 6

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
AEC-3	English Language and Communication: 3 OR हिंदी भाषा एव. सम्प्रेषण-3 OR संस्कृत भाषा एव. सम्प्रेषण-3								2					50

Semester 4

Course Code	Course Title	Course ID	Semester 4						Credits	MARKS				
			L	T	P	L	T	P		TI	TE	PI	PE	Total
			(Hrs)			Credits								
AEC-4	English Language and Communication: Level-4 OR हिंदी भाषा एव. सम्प्रेषण-4 OR संस्कृत भाषा एव. सम्प्रेषण-4								2					50

Department of Chemistry
B.Sc Physical Sciences
MULTIDISCIPLINARY COURSE (MDC) FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY
 (These courses are to be offered to students of different discipline/Subject)

Students of different discipline/Subject)														
Semester 1														
Course Code	Course Title	Course ID	L	T (theory)	P (prac.)	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-1	Introductory Chemistry-I		2		2	2		1	3	15	35	05	20	75

Semester 2														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-2	Introductory Chemistry-II		2		2	2		1	3	15	35	05	20	75

Semester 3														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MDC-3	Introductory Chemistry-III		2		2	2		1	3	15	35	05	20	75

Minor Course from the department for pool of the Courses in the University
 (These courses are offered by each department for students of other departments/same department to gain a broader understanding beyond the major discipline)

Course Code	Course Title	Course ID	Semester 1											
			L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-1	Green Chemistry		2			2			2	15	35			50

Course Code	Course Title	Course ID	Semester 2											
			L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-2	Bioinorganic Chemistry		2			2			2	15	35			50

Course Code	Course Title	Course ID	Semester 3											
			L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-3	Chemistry of biomolecules-I		3		2	3		1	4	25	50	5	20	100

Course Code	Course Title	Course ID	Semester 4											
			L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
MIC-4	Chemistry of		3		2	3		1	4	25	50	5	20	100

Department of Chemistry

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SKILL ENHANCEMENT COURSE FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 1

Semester I														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Chemistry lab operation and safety measures		2		2	2		1	3	15	35	05	20	75

Semester 2

Semester 2														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-2	Analytical Chemistry		2		2	2		1	3	15	35	05	20	75

Semester 3

Semester 3														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-3	Food Chemistry		2		2	2		1	3	15	35	05	20	75

Department of Chemistry

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SKILL ENHANCEMENT COURSE FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY

(These courses are offered by each department for students of other departments/same department and is designed to provide value-based and/or skill-based knowledge and should contain both theory and lab/hands-on/training/field work.)

Semester 1

Semester I														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-1	Chemistry lab operation and safety measures		2		2	2		1	3	15	35	05	20	75

Semester 2

Course Code	Course Title	Course ID	Semester 2						Credits	MARKS				
			L	T	P	L	T	P		TI	TE	PI	PE	Total
			(Hrs)			Credits								
SEC-2	Analytical Chemistry		2		2	2		1	3	15	35	05	20	75

Semester 3

Semester 3														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
SEC-3	Food Chemistry		2		2	2		1	3	15	35	05	20	75

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VALUE ADDED COURSE FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY

(All the departments will offer value added course for semester 3 for the students of same or different departments. In the first year, students will study

Human Values and Ethics and (ii) Environmental Studies as value added course)

Semester 1

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-1	<u>Human Values and Ethics</u> Or <u>Environmental Studies</u>		2						2	15	35			50

Semester 2

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-2	Human Values and Ethics OR Environmental Studies		2						2	15	35			50

Semester 4

Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VAC-3	Chemistry in everyday life-Soaps, detergents & dyes		2						2	15	35			50

Handwritten signature or mark.

Department of Chemistry
B.Sc Physical Sciences

VOCATION COURSE FROM THE DEPARTMENT FOR POOL OF THE COURSES IN THE UNIVERSITY
(These courses are offered by each department for students of other departments/same department and is focused on practical work, preparing students for a particular skilled profession.

Semester 5														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VOC-1	Agriculture and Fuel Chemistry		3		2	3		1	4	25	50	5	20	100

Semester 6														
Course Code	Course Title	Course ID	L	T	P	L	T	P	Credits	MARKS				
			(Hrs)			Credits				TI	TE	PI	PE	Total
VOC-2			3		2	3		1	4	25	50	5	20	100
VOC-3			3		2	3		1	4	25	50	5	20	100

Core Course (Multidisciplinary)

COURSE DETAILS:

Course Title	Chemistry-V
Semester	Semester-V
Course Code	CC-A5
Course ID	240/CHE/CC/501
Level of Course	
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)
Total Marks	100
Marks Distribution	Theory External: 50 Theory Internal: 25 Practical External: 20 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	Practical (P) Hours per Week: 2

COURSE OBJECTIVES:

- To understand the thermodynamic stability of metal complexes and the factors affecting their stability.
- To study the structure, bonding, and applications of organometallic compounds in catalysis.
- To explore the principles of UV absorption spectroscopy, including electronic transitions and conjugation effects.
- To learn the fundamental concepts of IR absorption spectroscopy and the interpretation of IR spectra for various organic compounds.
- To understand phase equilibria, phase diagrams, and the principles of adsorption.
- To analyze chemical kinetics, including reaction rates, rate laws, and mechanisms.

COURSE OUTCOMES:

Students will be able to:-

- Explain the thermodynamic stability of metal complexes and factors such as the Irving-Williams Series and Nephelauxetic effect.
- Describe the nature of metal-carbon bonds, hapticity, and applications of organometallic compounds in catalysis.
- Apply Beer-Lambert law to analyze UV spectra, and use Woodward-Fieser rules.
- Interpret IR spectra and analyze molecular vibrations, functional groups, and the effect of H-bonding.
- Apply Gibbs phase rule to interpret phase diagrams for single and two-component systems.

- Analyze reaction rates, derive rate laws, and apply the steady-state approximation and Arrhenius equation to chemical kinetics.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
I	Thermodynamic and Kinetic Aspects of Metal Complexes A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, Nephelauxetic effect, substitution reactions of square planar complexes of Pt[II], Trans effect. Organometallics Definition, Nature of Metal Carbon bond, Concept of hapticity, EAN rule, Structure and bonding in metal- ethylenic, metal-acetylenic complexes, Structure and bonding in Metal carbonyls, Applications of organometallic compounds as homogeneous catalysts in hydrogenation, hydroformylation, polymerization, oligomerization and metathesis reactions of alkenes and alkynes (Ziegler - Natta polymerization of ethylene and propylene.)	11
II	Ultraviolet (UV) absorption spectroscopy Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones, Woodward-Fieser rules, calculation of λ_{max} of simple conjugated dienes and α,β -unsaturated ketones (upto one DB extension), distinction between cis and trans isomers by UV. Infrared (IR) absorption spectroscopy Fundamental and non-fundamental molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, IR absorption positions of O, N and S containing functional groups, and interpretation of IR spectra of simple organic compounds, Hydrocarbons (saturated and unsaturated), hydroxy compounds, aldehydes, ketones, eseters, anhydrides, amides, amines and nitro compounds. Effect of H-bonding and ring size on IR absorptions.	12
III	Phase Equilibria Principles of phase equilibria: Discussing the fundamental concepts and criteria for phase equilibrium. Gibbs phase rule: Explaining the rule and its applications to phase diagrams. Phase diagrams for single and two-component systems: Analyzing the graphical representation and interpretation of phase behavior. Critical points and eutectic mixtures: Describing the significance and characteristics of these special points in phase diagrams. Adsorption: Gibbs adsorption equation, Adsorption isotherms, Types of adsorption, Surface area of adsorbents, Surface films on liquids	11
IV	Chemical Kinetics	11

	Basic concepts of chemical kinetics: Discussing the factors affecting reaction rates and the experimental methods for studying kinetics. Order and molecularity of reactions: Explaining their definitions and significance in kinetic studies. Differential and integrated rate laws: Analyzing the mathematical forms and their applications to different reaction orders. Kinetics of opposing, parallel, and consecutive reactions: Discussing the complexities and approaches for studying these types of reactions. Steady-state approximation in reaction mechanisms: Explaining the approximation and its use in simplifying complex mechanisms. Lindemann mechanism for unimolecular reactions: Analyzing the proposed mechanism and its implications for reaction rates. Temperature dependence of reaction rates: Discussing the Arrhenius equation and the concept of activation energy.	
V	Practicals: 1. Systematic qualitative analysis of organic compounds possessing monofunctional groups: amide, amines, halo-hydrocarbons and carbohydrates (Including Derivative preparation). 2. Identification of simple organic compounds by IR spectroscopy (Spectra to be provided). 3. Study of the kinetics of the saponification of ethyl acetate by sodium hydroxide. 4. Determination of the order of reaction using the iodine clock reaction. 5. Determination of activation energy for the reaction between sodium thiosulfate and hydrochloric acid. 6. Study of the effect of temperature on the rate of a reaction. 7. Study of adsorption isotherms (e.g., adsorption of acetic acid on activated charcoal). 8. Complexometric titrations: Determination of Mg^{2+}, Zn^{2+} by EDTA. 9. To verify Beer - Lambert law for $KMnO_4$ / $K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4$ / $K_2Cr_2O_7$ solution. 10. Characterization of complexes using infrared spectroscopy (Tetraamminecarbonatocobalt (III) ion, Potassium tris(oxalate)ferrate(III)), (spectra to be provided).	30

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

RECOMMENDED BOOKS

1. Inorganic Chemistry by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
2. Concise Inorganic Chemistry by J.D. Lee
3. Inorganic Chemistry: Principles of Structure and Reactivity by James E. Huheey, Ellen A. Keiter, and Richard L. Keiter
4. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
6. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K. International.
8. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016), Organic Chemistry, 12th Edition, Wiley.
9. Vogel's Textbook of Quantitative Chemical Analysis by A.I. Vogel (Adapted by G.H. Jeffery)

Bachelor of Science with Major in Chemistry
Core Course

COURSE DETAILS:

Course Title	Organic Chemistry-V	
Semester	Semester-5	
Course Code	CC-A14	
Course ID		
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)	
Total Marks	100	
Marks Distribution	Theory External: 50 Practical External: 20	Theory Internal: 25 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	Practicals (P) Hours per Week: 2

COURSE OBJECTIVES:

- Understand the classification, nomenclature, aromaticity, and reactivity of heterocyclic compounds with one heteroatom in 5- and 6-membered rings.
- Learn the general methods of synthesizing key heterocyclic compounds, including pyrrole, thiophene, pyridine, indole, quinoline, and isoquinoline.
- Explore the physical properties, substitution reactions, and other chemical transformations of heterocyclic compounds with mechanisms.
- Develop foundational knowledge of carbohydrates, their structures, reactions, and biological relevance, alongside an introduction to alkaloids and their structural elucidation.

COURSE OUTCOMES:

- Students will be able to analyze the aromaticity, basicity, and reactivity of 5- and 6-membered heterocyclic compounds containing one heteroatom.
- Apply various synthetic methods to prepare important heterocyclic compounds like pyrrole, indole, quinoline, and isoquinoline.
- Explain electrophilic and nucleophilic substitution reactions, oxidation, reduction, and other transformations of heterocyclic compounds.
- Interpret the structural features, configurations, and reactions of carbohydrates, including monosaccharides, disaccharides, and polysaccharides.
- Elucidate the structures, synthesis, and physiological actions of alkaloids, including nicotine, using general and specific methods.



DETAILED CONTENT OF COURSE:

Theory & Practical Syllabus:

Total Contact Hours: 45 (Theory) + 30 (Practical)

Unit	Topics	Contact Hours
I	Heterocyclic Compounds-I Introduction, Importance of heterocyclic compounds in various fields, Classification and nomenclature of heterocyclic compounds (containing only one heteroatom), Structure and aromaticity in 5-membered and 6-membered rings containing one heteroatom, Basicity and relative reactivity towards electrophilic substitution reactions (amongst five-membered and six-membered rings). General Methods of Synthesis: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Indole (Fischer indole synthesis, Madelung synthesis, reduction of o-nitrobenzaldehyde), Quinoline and Isoquinoline (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction).	11
II	Heterocyclic Compounds-II Physical properties, Electrophilic substitution reactions (Nitration, sulphonation, halogenation, formylation, acylation, mercuration, and carboxylation) of Furan, Pyrrole, Thiophene, Pyridine, Indole, Quinoline, and Isoquinoline with mechanism. Oxidation, Reduction, Addition, Reactions showing acidic/basic character, Reaction with diazonium salts, Ring opening, Ring expansion and Nucleophilic substitution reaction wherever applicable should be discussed.	12
III	Carbohydrates Classification and nomenclature of Monosaccharides, mechanism of osazone formation, interconversion of glucose, fructose and mannose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)-glucose & D(-) fructose. Mechanism of mutarotation. An introduction to disaccharides (maltose, sucrose and lactose; reducing and non-reducing) and polysaccharides (starch and cellulose) without involving structure determination.	11
IV	Alkaloids Introduction, Natural occurrence, Classification, Uses, general structural features, general methods for structure elucidation including Hoffmann's exhaustive methylation and Emde's method. Structure elucidation, synthesis and physiological action of Nicotine.	11
V	Practical 1. Estimation of glucose by Fehling's solution. 2. Isolation of caffeine from tea leaves.	30

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	3. Qualitative analysis of unknown organic compounds containing monofunctional groups: aromatic hydrocarbons, aryl halides, carbohydrates, nitro compounds, amines, amides and simple compounds containing bifunctional groups, e.g. salicylic acid, cinnamic acid, nitrophenols.	
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COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-I will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

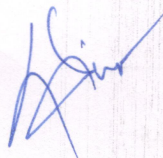
SUGGESTED BOOKS

1. Finar, I. L. Organic Chemistry (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2016). Organic Chemistry, 12th Edition, Wiley.
3. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P. (2013). Organic Chemistry, Oxford University Press.
4. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006). Biochemistry. W.H. Freeman and Co.
5. Nelson, D.L.; Cox, M.M.; Lehninger, A.L. (2009). Principles of Biochemistry. W.H. Freeman and Co.
6. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education.
7. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.



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8. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
9. Kumar, A.; Garg, S.; Garg, N. (2012), Biochemical Tests: Principles and Protocols. Viva Books.



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COURSE DETAILS:

Course Title	Inorganic Chemistry-V	
Semester	Semester-5	
Course Code	CC-A13	
Course ID		
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)	
Total Marks	100	
Marks Distribution	Theory External: 50 Practical External: 20	Theory Internal: 25 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	Practical (P) Hours per Week: 2

COURSE OBJECTIVES

1. To understand the thermodynamic and kinetic aspects of metal complexes, including stability, trans effect, and substitution reactions.
2. To study the magnetic properties of transition metal complexes and their correlation with electronic configurations.
3. To analyze the electronic spectra of transition metal complexes using selection rules, spectroscopic states, and energy level diagrams.
4. To introduce the theoretical aspects of precipitation, solubility product, and co-precipitation.
5. To understand the principles of qualitative and quantitative inorganic analysis, including interferences and removal techniques.
6. To develop practical skills for systematic qualitative analysis of acidic and basic inorganic radicals.

COURSE OUTCOMES

By the end of the course, students will be able to:

1. Explain the thermodynamic stability and substitution reactions of metal complexes, including the Irving-William series and trans effect.
2. Determine the magnetic properties of transition metal complexes and interpret magnetic moment data for 3d systems.
3. Analyze the electronic spectra of transition metal complexes using spectroscopic ground states and Orgel diagrams.
4. Apply the theory of precipitation, solubility product, and common ion effect in qualitative analysis.
5. Perform qualitative analysis for the identification of basic radicals (Group I, Group II) and acidic radicals (carbonate, sulfide, sulfate, and nitrate).
6. Demonstrate systematic inorganic analysis techniques, including managing



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Core Course

interferences for accurate identification of radicals.

DETAILED CONTENT OF COURSE:

Theory & Practical Syllabus:

Total Contact Hours: 45 (Theory) + 30 (Practical)

Unit	Topics	Contact Hours
I	Thermodynamic and Kinetic Aspects of Metal Complexes A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, Nephelauxetic effect, substitution reactions of square planar complexes of Pt(II), Trans effect.	11
II	Magnetic properties of Transition metal complexes Types of magnetic materials, magnetic susceptibility and its method of determination, spin only formula, L-S coupling, correlation of μ_{spin} and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.	11
III	Electronic spectra of Transition metal complexes Selection rules for d-d transition, spectroscopic ground states, spectrochemical series, Orgel energy level diagram for d^1 and d^9 states, discussion of electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{+3}$ complex ion.	11
IV	Theory of Precipitation: Theory, common ion effect, solubility product, purification of precipitates, co-precipitation and post-precipitation Theory of Qualitative and Quantitative Inorganic Analysis: Chemistry of analysis of various groups of basic and acidic radicals, chemistry of identification of acid radicals in typical combinations. Chemistry of interferences of acid radicals including their removal in the analysis of basic radicals.	12
V	Practical Systematic analysis of acidic and basic inorganic radicals • Qualitative analysis of basic radicals: Group I (Ag^+ , Pb^{2+} , Hg^{2+}). • Qualitative analysis of basic radicals: Group II (Cu^{2+} , Cd^{2+} , Bi^{3+}). • Qualitative analysis of acidic radicals: carbonate, sulfide, sulfate, and nitrate ions.	30

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

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Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

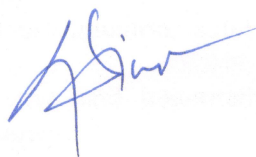
Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting of short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

SUGGESTED BOOKS

1. "Advanced Practical Inorganic Chemistry" by G. D. Tuli
2. "Inorganic Chemistry" by Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr
3. "Concise Inorganic Chemistry" by J.D. Lee
4. "Inorganic Chemistry" by Shriver and Atkins (Adapted by M.J. Weller)
5. "Concepts of Inorganic Chemistry" by B.R. Puri, L.R. Sharma, and K.C. Kalia
6. "Vogel's Textbook of Quantitative Chemical Analysis" by A.I. Vogel (Adapted by G.H. Jeffery)
7. "Quantitative Chemical Analysis" by Daniel C. Harris
8. "Inorganic Chemistry for Undergraduates" by R.L. Madan



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Core Course

COURSE DETAILS:

Course Title	Physical Chemistry-V	
Semester	Semester-V	
Course Code	CC-A15	
Course ID		
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)	
Total Marks	100	
Marks Distribution	Theory External: 50 Practical External: 20	Theory Internal: 25 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5	
Lectures (L) Hours per Week: 3	Practicals (P) Hours per Week: 2

COURSE OBJECTIVES:

- To understand the fundamental principles and criteria of phase equilibria and their practical applications.
- To analyze phase diagrams of single and two-component systems and explain critical points and eutectic mixtures.
- To explore the conductivity of electrolytes, ionic interactions, and their theoretical treatments in electrochemistry.
- To study the concepts of electromotive force, Nernst equation, and their applications in electrochemical cells.
- To develop hands-on skills in determining conductance, electrode potentials, and electrolysis-related parameters through practical experiments.

COURSE OUTCOMES:

- Students will be able to interpret phase equilibria concepts and analyze phase diagrams for single and binary systems.
- Students will demonstrate an understanding of electrolyte conductivity, equivalent conductance, and ionic interactions using Kohlrausch's law and related theories.
- Students will analyze the quantitative and practical aspects of electrolysis, including its applications in metallurgy and industry.
- Students will apply the Nernst equation to predict cell potentials and understand EMF measurements for various electrochemical systems.
- Students will perform laboratory experiments to measure conductance, dissociation constants, electrode potentials, and evaluate electrolytic properties.



DETAILED CONTENT OF COURSE:

Theory & Practical Syllabus

Total Contact Hours: 45 (Theory) + 30 (Practical)

Unit	Topics	Contact Hours
I	SOLUTIONS AND PHASE EQUILIBRIA Solutions Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule, Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. Phase Equilibria Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $\text{FeCl}_3\text{-H}_2\text{O}$ and Na-K only).	15
II	Electrochemistry - I Conductivity of electrolytes: Discussing the factors affecting conductivity and its measurement. Equivalent and molar conductivity: Explaining their definitions and significance in electrochemical systems. Kohlrausch's law: Describing the additive nature of ionic conductivities and its applications. Debye-Hückel-Onsager equation: Analyzing the theoretical treatment of ionic interactions in dilute solutions.	8
III	Electrochemistry - II Ionic velocities, mobilities, and transference numbers: Discussing their definitions, measurement, and significance in electrochemical processes. Applications of conductance measurements: Including determining ion concentrations and studying reaction kinetics. Quantitative aspects of Faraday's laws of electrolysis: Explaining the relationship between electrical charge and chemical change. Applications of electrolysis in metallurgy and industry: Discussing the practical uses of electrolysis in metal extraction and production.	11
IV	Electrochemistry - III Electromotive force of a cell: Discussing the factors affecting EMF and its measurement. Nernst equation: Explaining its derivation and applications in predicting cell potentials. Standard electrode potentials: Describing the reference values for electrode potentials and their use in electrochemical series. Concentration cells: Discussing the principles and applications of cells with varying concentrations of electrolytes. Applications of EMF measurements: Including potentiometric titrations	11

	and determining thermodynamic properties.	
V	Practicals: 1. To determine the standard electrode potential (E°) of a given redox couple. 2. To determine the conductance of a given solution using a conductivity meter. 3. To study the effect of concentration on the conductance of a solution. 4. To determine the dissociation constant (K_a) of a weak acid using conductometry. 5. To perform electrolysis of aqueous solutions and determine the applicability of Faraday's laws. 6. To construct electrochemical cells and measure their cell potentials. 7. To determine the transport number of ions using the moving boundary method. 8. To determine the activity coefficient of electrolytes using EMF measurements. 9. To determine the molar conductance of strong and weak electrolytes.	30

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

Recommended Textbooks:

Theory:

1. Physical Chemistry – P.W. Atkins and J. de Paula, Oxford University Press.
2. Principles of Physical Chemistry – Puri, Sharma, and Pathania, Vishal Publishing Co.
3. Physical Chemistry: A Molecular Approach – D.A. McQuarrie and J.D. Simon, University Science Books.
4. Thermodynamics for Chemists – S. Glasstone, East-West Press.
5. Essentials of Physical Chemistry – B.S. Bahl, G.D. Tuli, and Arun Bahl, S. Chand Publishing.
6. Introduction to Modern Thermodynamics – D. Kondepudi, Wiley.
7. Electrochemistry – Carl H. Hamann, Andrew Hamnett, and Wolf Vielstich, Wiley-VCH.
8. Modern Electrochemistry – J.O'M. Bockris and A.K.N. Reddy, Springer.
9. Electrochemistry: Principles, Methods, and Applications – C.M.A. Brett and A.M.O. Brett, Oxford University Press.
10. Phase Equilibria in Chemical Engineering – Stanley M. Walas, Butterworth-Heinemann.
11. Chemical Thermodynamics and Information Theory with Applications – Daniel J. Graham, Springer.

Practical:

1. "Experiments in Physical Chemistry" by C. N. R. Rao and U. C. Agarwala
2. "Practical Physical Chemistry" by B.S. Bahl and Arun Bahl



VOC (Multidisciplinary)

COURSE DETAILS:

Course Title	Agriculture and Fuel Chemistry	
Semester	Semester-V	
Course Code	VOC-01	
Course ID		
Level of Course		
Total Credits	04 (Lecture: 03, Tutorial: 0, Practical: 01)	
Total Marks	100	
Marks Distribution	Theory External: 50 Practical External: 20	Theory Internal: 25 Practical Internal: 05

COURSE CURRICULUM DELIVERY WEEKLY DISTRIBUTION:

Total Hours per Week: 5		
Lectures (L) Hours per Week: 3	Practical (P) Hours per Week: 2	

COURSE OBJECTIVES:

- To understand soil fertility, soil productivity, and factors affecting plant growth.
- To study the chemical composition of the Earth's crust and soil, including major elements and minerals.
- To learn the formation, types, and properties of coal and petroleum.
- To understand the applications of fertilizers, fuels, and natural resources in daily life and industry.
- To develop awareness about sustainable use and conservation of soil and energy resources.

COURSE OUTCOMES:

Students will be able to:-

- Students will learn to evaluate the use of fertilizers, and bio-fertilizers for improving soil productivity.
- Students will explain the formation of coal and petroleum.
- Students will classify types of coal and their properties.
- Students will describe petroleum refining and its products.

DETAILED CONTENT OF COURSE:

Theory Syllabus: Total Contact Hours: 45

Unit	Topics	Contact Hours
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I	Soil fertility and soil productivity: urea cycle, Organic and inorganic nitrogen (Haber Bosch Process), nutrient sources-fertilizers and manures; essential plant nutrients-functions and deficiency symptoms. Micronutrients-critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.	11
II	Chemical (elemental) composition of the earth's crust and soils; Chemistry of acid soils; active and potential acidity; lime potential, chemistry of acid soils; sub-soil acidity; Chemistry of salt-affected soils and amendments; soil pH, Electrical conductivity, ESP, SAR and important relations; soil management and amendments. Sewage and industrial effluents-their composition and effect on soil properties/health.	12
III	Coal: brief introduction of energy sources (renewable and non-renewable), classification of fuel and their calorific value, uses of coal in various industries, its composition, carbonization of Coal. Coal gas, producer gas and water gas- composition and applications. Fractionation of coal tar, uses of coal tar bases chemicals, Coal gasification (hydro gasification and catalytic gasification)	11
IV	Petroleum: Composition of crude petroleum, refining and different type of petroleum product and their applications, cracking-thermal catalytic cracking, reforming of petroleum and non-petroleum fuels (LPG, CNG, LNG, Bio-gas, Fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: vinyl acetate, propylene oxide, isoprene and their uses.	11
Practical		
V	1. Determination of pH of Soil 2. Determine carbonate and bicarbonate in soil 3. Determine chloride in the soil sample 4. Determine starch in organic manure 5. Determine nitrate in the soil 6. Determine sulphate in the soil 7. Determination of viscosity of lubricating oils using Ostwald's viscometer 8. Determination of acid value of lubricating oil by titration 9. Determination of saponification value of oil 10. Detection of adulteration in petrol and diesel	30

COURSE EVALUATION METHODS

Theory Exams: Total Marks: 75 (External: 50 + Internal: 25)

Internal Assessment: 25 Marks	• Class Participation: 05 Marks • Seminar/Presentation/ Assignment: 05 Marks • Mid Term Exam: 15 Marks
External Assessment: 50 Marks (02 Hours)	• End Term Exam: 50 Marks

Practical Exam: Total Marks: 25 (External: 20 + Internal: 05)

Bachelor of Science with Major in Chemistry
Vocational Course

Internal Assessment: 05 Marks	• Class Participation: 05 Marks
External Assessment: 20 Marks (02 Hours)	• End Term Practical Exam: 10 Marks • Lab record: 05 Marks • Viva Voce: 05 Marks

Instruction for End-Term Theory Exam:

The Examiner is requested to set nine questions in total, selecting two questions from each section. Question-1 will be a compulsory question consisting short answer type questions covering all the units of the syllabus. All questions should carry equal marks. Log table and non-programmable calculator is allowed.

RECOMMENDED BOOKS

1. Pal D.K. (2017), A Treatise of Indian and Tropical Soils, Springer Cham.
2. Grotzinger John and Jordan Thomas H. (2010), Understanding Earth. 6th Edition., W.H. Freeman and company, New York.
3. Bruce, V.; Alain, M. (2008), The origin of Clay Minerals in Soils and Weathered Rocks, Springer Berlin, Heidelberg.
4. Klein C., Dutrow B., Dwight J., and Klein C. (2007). The 23rd Edition of the Manual of Mineral Science (after James D. Dana). J. Wiley & Sons.
5. Deer, W. A., Howie, R. A., & Zussman, J. (1992). An introduction to the rock-forming minerals (Vol. 696). London: Longman.
6. Bear RE. 1964. Chemistry of the Soil. Oxford and IBH. Bolt GH & Bruggenwert MGM. 1978. Soil Chemistry. Elsevier. Greenland DJ & Hayes MHB. 1981. Chemistry of Soil Processes. John Wiley & Sons.
7. Brady NC & Weil RR. 2002. The Nature and Properties of Soils. 13 Ed. Pearson Edu.
8. Kabata-Pendias A & Pendias H. 1992. Trace Elements in Soils and Plants. CRC Press.
9. Kannaiyan S, Kumar K & Govindarajan K. 2004. Biofertilizers Technology. Scientific Publ.
10. Leigh JG. 2002. Nitrogen Fixation at the Millennium. Elsevier.
11. Mengel K & Kirkby EA. 1982. Principles of Plant Nutrition. International Potash Institute, Switzerland.
12. Mörtvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. Micronutrients in nd Agriculture. 2 Ed. SSSA, Madison.
13. Pierzinsky GM, Sims TJ & Vance JF. 2002. Soils and Environmental nd Quality. 2 Ed. CRC Press.
14. Speight, J. G. (2014). The chemistry and technology of petroleum (5th ed.). CRC Press.
15. Speight, J. G. (2011). Petroleum: Chemistry, refining, and fuels. CRC Press.
16. Gupta, O. P. (1989). Elements of Fuels, Furnaces & Refractories, 6th Edition., Khanna Publishers, India.
17. R. Gopalan, D. Venkappayya, S. Nagarajan: Engineering Chemistry, Vikas Publications, New Delhi.
18. Stocchi, E., Industrial Chemistry, Vol. I, Ellis Horwood Ltd. UK (1990).
19. Jain, P.C.; Jain, M. Engineering Chemistry, Dhan Patrai & Sons, Delhi (2013).
20. Sharma, B. K., Industrial Chemistry, Goel Publishing House, Meerut (2016).
21. Vermani, O. P.; Narula, A. K., Industrial Chemistry, Galgotia Publications Pvt. Ltd., New Delhi (2004).

