Academic Council Meeting No. and Date :10 / April 26, 2025
Agenda Number: 3 Resolution Number: 46,47/3.3, 3.8

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science
(Autonomous), Thane

Syllabus for

Programme Code: BUCH

Programme: Bachelor of Science

Specific Programme: Chemistry

(Major/Minor)

[T. Y. B. Sc. Chemistry]

Level 5.5

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2025-2026

Preamble

In continuation of the Choice Based Credit System (CBCS) introduced by the University of Mumbai in the academic year 2016–2017, the existing syllabus for T.Y.B.Sc. (Level 5.5) has been thoughtfully restructured in accordance with the National Education Policy (NEP - 2020) reforms. This restructured syllabus will be implemented from the academic year 2025–26 under the autonomous status of VPM's B. N. Bandodkar College of Science.

The B.Sc. (Chemistry) programme is designed to equip students with both foundational and applied knowledge in chemistry, enhancing their employability, entrepreneurship and preparing them for industry-relevant roles. The curriculum emphasizes practical training, innovation, and the development of technical and transferable skills.

Objectives of the Programme:

1. To cultivate curiosity and deepen understanding of fundamental principles in chemistry.
2. To enable students to manage field and laboratory projects while considering human, financial, and environmental aspects with societal benefits.
3. To foster critical thinking, teamwork, and leadership skills.
4. To prepare graduates for employment and career advancement in chemical and allied industries.
5. To enhance the ability to communicate scientific knowledge to both technical and non-technical audiences.
6. Inculcate the green techniques in the lab experiment.

The curriculum is aligned with current industry trends and spans a comprehensive range of subjects over three years. Graduates will be prepared for employment across various sectors such as: Electrochemistry, semiconductors, polymer chemistry, instrumentation, glassware and instrument industries, environmental chemistry, pharmaceutical and drug chemistry, Biochemistry, cement industry, food and drug industries, medicinal chemistry, dyes and paint industries, oil and gas industries, chemical laboratories (NGO and Government), forensic sciences, FDA, pollution control boards, metallurgy and alloy industries, perfumery, quality control and assurance, research and development (R&D), and digital domains including Chemdraw, cheminformatics, bioinformatics, computational chemistry, and scientific animation.

The syllabus also incorporates training in business management, chemical technology, entrepreneurial skills, pharmaceutical management, and hospital administration, preparing students for a broad spectrum of professional roles.

We are dedicated to have holistic development of students.

Dr. Ajit N Bhumkar
Chairperson, BOS Chemistry
VPM's B.N.Bandodkar College of Science (Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instill ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behavior in all aspects of life.

Eligibility: Level 5.0 (S. Y. B. Sc.)

Duration: 3 years (Syllabus for Third Year semester V & VI)

Mode of Conduct: Laboratory Practicals/Offline lectures/ Online lectures

Discipline/Subject: Chemistry

Specific Programme: B.Sc. CHEMISTRY

Level: 5.5

Qualification Title: UG certificate

Discipline/Subject: CHEMISTRY

Program Specific Outcomes-CHEMISTRY

1.	**PSO 1: Core Chemical Knowledge** Students will acquire a strong foundational understanding of inorganic, organic, physical, and analytical chemistry, enabling them to explain chemical principles, molecular behavior, and reaction patterns across all three years.	L2
2.	**PSO 2: Laboratory Skills & Instrumentation** Students will develop competency in classical and modern laboratory techniques, including titrimetry, chromatography, spectroscopy, and safe handling of chemicals, ensuring precise experimentation and reliable data generation.	L3

3.	**PSO 3: Chemical Calculations & Data Interpretation** Students will master stoichiometric calculations, concentration units, titration curves, spectral interpretation, and other quantitative tools required for scientific reasoning and problem-solving.	L4
4.	**PSO 4: Synthetic and Analytical Problem-Solving** Students will learn to plan, execute, and troubleshoot organic and inorganic syntheses, purifications, and qualitative/quantitative analyses using logical thinking and evidence-based approaches.	L4
5.	**PSO 5: Application of Chemistry to Industry, Environment & Society** Students will understand the role of chemistry in pharmaceuticals, materials, environment, agriculture, energy, and sustainability, fostering responsible thinking and real-world application.	L5
6.	**PSO 6: Scientific Communication, Ethics & Teamwork** Students will develop skills to record, analyze, and present scientific information effectively while demonstrating integrity, safety consciousness, and collaborative behavior in laboratory and academic settings.	L6
Specific Programme: T. Y. B. Sc. (CHEMISTRY -Major/ Minor)		

Assessment: Weightage for assessments (in percentage) For Major

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40%	60%

Proposed Structure and Credit Distribution for level 5.5 (T.Y.B.Sc)for the year of 2025-26

Level	SEM.	Faculty – DSC			Any Faculty	Vocational & Skill Enhancement Courses (VSC)	Field Project/ Apprenticeship/ Community Engagement& Services		Credit	Cumulative Credits
		Major	Elective	Minor	GE & OE	CREDITS = 02	Field Project / OJTOJT Apprenticeship/ On the job training			
		Credits	Credits	credits	CREDITS	VSC				
5.5	V.	12	04	02	-	02	02	-	22	44
	VI.	14	04	-	-	02	02	-	22	
Exit option: Award of UG Certificate in Major with 80-88 credits and an additional 4 credits core NSQF courses / Internship or Continue with Major and Minor.										
Transforming S.Y. BSc. Curriculum into NEP 2020 Structure provided by Government of Maharashtra.										
Cum cr.		14*2 = 28	02+04 = 06	02	-	2*2= 04	2*2 = 04	-	44	44

Level	SEM	Faculty – Science **(10T 8P) =** DSC (6 T+ 6P) + DSE – **SEM V** (2T+2P) credits 2 Opted Minor subject – (2T) credits 2 **(10T 8P) =** DSC (8 T+ 6P) + DSE – **SEM VI** (2T+2P) credits 4									Minor SEM V (2T)	Vocational & Skill Enhancement Courses (VSC)	Field Project	Credit	Cumulative Credits
		Major							Major DSE		Credits (02)				
		Theory Course– I	Theory Course – II	Theory Course –III	Theory Course– IV	Practical Course – I	Practical Course – II	Practical Course – III	Theory Course – I	Practical Course – II	Syllabus directly relevant to the employability /Entrepreneurship				
Level 5.5	V	02 (2T)	02 (2T)	02 (2T)	--	02 (2P)	02 (2P)	02 (2P)	(2T)	(2P)	(2T)	02 (1T + 1P)	02	22	44
	VI	02 (2T)	02 (2T)	02 (2T)	0 2 (2T)	02 (2P)	02 (2P)	02 (2P)	02 (2T)	02 (2P)	-	02 (1T + 1P)	02	22	
	Cum cr.	12+14 = 26							4+4 = 08		02	2*2 = 04	2*2 = 04 -	44	

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

T.Y.B.Sc.

Curriculum Structure for the Undergraduate Degree Program T.Y.B.Sc. Chemistry

Structure of Programme

Semester-wise Titles of the Papers in T.Y.B.Sc.

Year	Sem.	Course code	Course Title	Theory/ Practical	No. of Lectures	Credits
Third Year	V	**Major courses**				
		25BUCH5T01	Advances in Physical Chemistry-I	Theory	30	02
		25BUCH5T02	Advances in Inorganic Chemistry-I	Theory	30	02
		25BUCH5T03	Advances in Organic Chemistry-I	Theory	30	02
		25BUCH5P01	Practicals Based on **25BUCH5T01**	Practical	60	02
		25BUCH5P02	Practicals Based on **25BUCH5T02**	Practical	60	02
		25BUCH5P03	Practicals Based on **25BUCH5T03**	Practical	60	02
			Total		**270**	**12**
		DSE				
		25BUCH5TE1	Advances in Analytical Chemistry-I	Theory	30	02
		25BUCH5PE1	Practicals Based on **25BUCH5TE1**	Practical	60	02
			Total		**90**	**04**
		OR				
		25BUCH5TE2	Industrial and Environmental Chemistry	Theory	30	02
		25BUCH5PE2	Practicals Based on 25BUCH5TE2	Practical	60	02
			Total		**90**	**04**
		Minor				
		25BUCH5TMN	Dyes Chemistry	Theory	30	02
			Total		**30**	**02**

		VSC				
		25BUCH5VSC	Chemtech: Vocational excellence in chemical Applications	Theory	15	01
			Practicals Based on 25BUCH5VSC	Practical	30	01
		25BUCH5OJT/ 25BUCH5FPR	On Job Training in Chemistry-I/ Field Project in Chemistry-III	Practical	60	2
			Total		**105**	**04**
			Total		585	26
	VI	**Major courses**				
		25BUCH6T01	Advances in Physical Chemistry-II	Theory	30	02
		25BUCH6T02	Advances in Inorganic Chemistry-II	Theory	30	02
		25BUCH6T03	Advances in Organic Chemistry-II	Theory	30	02
		25BUCH6IKS	Indian Knowledge System in Chemical Sciences	Theory	30	02
		25BUCH6P01	Practicals Based on 25BUCH6T01	Practical	60	02
		25BUCH6P02	Practicals Based on 25BUCH6T02	Practical	60	02
		25BUCH6P03	Practicals Based on 25BUCH6T03	Practical	60	02
					300	**14**
		DSE (Discipline Specific Elective Courses				
		25BUCH6TE1	Advances in Analytical Chemistry-II	Theory	30	02
		25BUCH6PE1	Practicals Based on **25BUCH6TE1**	Practical	60	02
					90	**04**
		OR				
		25BUCH6TE2	Chemistry of Soil and Dairy	Theory	30	02
		25BUCH6PE2	Practicals Based on **25BUCH6TE2**	Practical	60	02
					90	**04**
		VSC (Vocational Skill Enhancement Course)				
		25BUCH6VSC	Pharmaceuticals Chemistry	Theory	15	01

			Practicals Based on 25BUCH6VSC	Practical	30	01
		25BUCH6OJT/ 25BUCH6FPR	On Job Training in Chemistry- II / Field Project in Chemistry-IV	Practical	60	2
			Total		**105**	**04**
			Total		**585**	**26**
Total Credits					**44**	

Semester V

Course Code 25BUCH5T01	Course Title: Advances in Physical Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Explain and apply the molecular spectroscopy principle.	L3
CO2	Describe the concepts of thermodynamics and rate of chemical reaction.	L2
CO3	Understanding fundamental concepts, knowledge of nuclear reactions application of radioactive decay law, practical application of radioactivity	L3
CO4	Discuss surface phenomena, adsorption isotherm, BET equation and colloidal states	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	0
CO2	3	1	0	0	0	0
CO3	2	2	0	3	0	0
CO4	2	1	0	3	0	0

UNIT I	**1.1 MOLECULAR SPECTROSCOPY (08L)** **1.1.1. Rotational spectrum**: Introduction to dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure, Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia energy levels, conditions for obtaining pure rotational spectrum. (Numericals are expected) **1.1.2. Vibrational spectrum**: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero-point energy. **1.1.3. Raman Spectroscopy-** Scattering of electromagnetic radiation, Rayleigh scattering and Raman Scattering, Stoke's and anti-stoke's lines. **1.2 Colligative properties: (05)** **1.2.1** Vapour pressure and relative lowering of vapour pressure. Measurement of lowering of vapour pressure-Static method, Practical utility of chemical thermodynamic. **1. 2. 2. Solutions of Solid in Liquid:** 2.1.2.1 Elevation in boiling point of a solution 2.1.2.2 Depression in freezing point of a solution **2.1.2.3 Osmotic Pressure:** Introduction, thermodynamic derivation of Van't Hoff equation, Van't Hoff factor. Measurement of Osmotic Pressure-Berkeley and Hartley's Method, Reverse Osmosis. **1.2. CHEMICAL KINETICS (02L)** **1.3.1.** Collision theory of reactions rates, Classification of reactions (Slow, fast and ultra-fast)	**15**
UNIT II	**2.1 NUCLEARCHEMISTRY (08L)** 2.1.1Introduction: Basic terms-radioactive constants (decay constant, half-life and average life) and units of radioactivity 2.1.2 Detection and Measurement of Radioactivity: Types and characteristics of nuclear radiations, detection and measurement of nuclear radiations using G.M. Counter and Scintillation Counter. 2.1.3Applicationofuse of radioisotopes as Tracers: chemical reaction mechanism, age determination – dating by C^{14} 2.1.4 Nuclear reactions: nuclear transmutation (one example For each projectile), artificial radioactivity, Q - value of nuclear reaction, threshold energy.(Numericals are expected) 2.2 SURFACE CHEMISTRY (06L)	**15**

	2.2.1 Adsorption: Physical and Chemical Adsorption, types of Adsorption isotherms. Langmuir's adsorption isotherm (Postulates and derivation expected). 2.2.2 B.E.T. equation for multi-layer adsorption, (derivation not expected) 2.3 Introduction to Colloids: (01) Classifications and Applications of surfactants.	

Reference Books:

1. Physical Chemistry, Ira Levine,5th Edition, 2002 Tata Mc Graw Hill Publishing Co. Ltd.
2. Physical Chemistry, P. C. Rakshit, 6th Edition, 2001, Sarat Book Distributors, Kolkota.
3. Fundamental of Molecular Spectroscopy, 4th Edition, Colin N Banwell and Elaine M Mc Cash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
4. The Elements of Physical Chemistry, P. W. Atkins, 2nd Edition Oxford University Press Oxford.
5. Principles of Physical Chemistry B. R. Puri, L. R. Sharma, M. S. Pathania, Vishal Publishing Company, 2008.
6. Essentials of Nuclear Chemistry, Arnikar, Hari Jeevan, New Age International(P)Ltd., Publishers, 2011.
7. Chemical Kinetics, K. Laidler, Pearson Education India,1987.

Course Code 25BUCH5T02	Course Title: Advances in Inorganic Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Apply- molecular symmetry concepts,symmetry elements, symmetry operations, and point groups and criteria for optical moments based on symmetry.	L3
CO2	Understand crystal structures,atomic packing factor, point defects, and superconductivity concepts, types and application	L2
CO3	Explain the chemistry of lanthanides, including their electronic configuration concept of lanthanide contraction and consequences, oxidation states, complex formation, and magnetic and spectral properties.	L3
CO4	Describe the occurrence, extraction, separation methods, and applications of lanthanides.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	2
CO2	3	1	0	1	0	2
CO3	3	2	1	0	0	3
CO4	3	1	0	1	0	3

UNIT I	Molecular Symmetry and Solid-State Chemistry 1. Molecular Symmetry (6L) 1.1 Introduction and Importance of Symmetry in Chemistry. 1.2 Symmetry elements and Symmetry operations. 1.3 Concept of a Point Group with illustrations using the following point groups :(i) C∞V (ii) D∞h (iii) C_2V (iv) C_3v (v) C_2h and (vi)D_3h 1.4 Symmetry Criteria for optical activity, chiral and achiral point groups 2 Solid state Chemistry 2.1 Structures of Solids (5L) 2.1.1 Introduction of basic terms of solid states, Closest packing of rigid spheres (hcp,ccp), packing density in simple cubic, bcc and fcc lattices. 2.1.3 Stoichiometric Point defects in solids (discussion on Frenkel and Schottky defects expected). 2.2 Superconductivity (4L) 2.2.1 Discovery of superconductivity. 2.2.2 Explanation of terms like superconductivity, transition temperature, Meissner effect. 2.2.3 Different types of super conductors viz. conventional superconductors, alkali metal fullerides, high temperature super conductors. 2.2.4 Brief application of superconductors.	**15**

UNIT II	2 Chemistry of inner transition elements (15L) 2.1 Introduction: Position in periodic table and electronic configuration of lanthanides and actinides. 2.2 Chemistry of Lanthanides with reference to (i) lanthanide contraction and its consequences (ii) Oxidation states (iii) Ability to form complexes (iv) Magnetic and spectral properties 2.3 Occurrence, extraction and separation of lanthanides by (i) Ion Exchange method and (ii) Solvent extraction method (Principles and technique) 2.4 Applications of lanthanides	**15**

Reference Books:

1. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002.
2. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
3. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
4. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
5. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates. Chemistry of Transition Elements Pg.- 608 – 679 .
6. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359-648.
7. CNR Rao edited, University General Chemistry, 513-578.
8. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
9. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
10. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
11. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University press

Course Code 25BUCH5T03	Course Title: Advances in Organic Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Explain photochemical processes, reaction mechanisms, and applications.	L3
CO2	Describe the synthesis, reactivity, and reactions of pyridine-N-oxide, quinoline, and isoquinoline.	L2
CO3	Discuss the structure, synthesis, and significance of terpenoids, alkaloids, amino acids, and peptides.	L3
CO4	Develop an understanding of monosaccharide structures, stereochemistry, mutarotation, and key molecular rearrangements in organic chemistry.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	0
CO2	3	1	0	0	0	0
CO3	3	2	0	1	0	0
CO4	3	3	1	0	0	0

UNIT I	**1.1 PHOTOCHEMISTRY (6 L)** 1.1.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram and photosensitization. 1.1.2 Photochemical reactions of olefins: photoisomerization, di- π methane rearrangement. 1.1.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photo reduction (e.g. benzophenone to benzpinacol) **1.2 Heterocyclic chemistry: (9 L)** 1.2.1 Preparation of pyridine-N-oxide, quinoline (Skraup synthesis) and iso-quinoline (Bischler Napieralski synthesis). 1.2.2 Reactions of pyridine-N-oxide: halogenation, nitration and reaction with $NaNH_2$/liq.NH_3, n-BuLi. 1.2.3 Reactions of quinoline and isoquinoline; oxidation, reduction, nitration, halogenation and reaction with $NaNH_2$/liq.NH_3, n-BuLi.	**15**
UNIT II	**2.1 NATURAL PRODUCTS: (6L)** 2.1.1. Terpenoids: Introduction, and classification of Natural product 2.1.2 Citral: a) Synthesis of citral from methyl heptenone b) Isomerism 2.1.3. Alkaloids: Introduction and occurrence. Hofmann's exhaustive methylation and degradation in: simple open chain and N – substituted monocyclic amines. 2.1.4 Nicotine: a) Synthesis of nicotine from nicotinic acid b) Harmful effects of nicotine. **2.2 AMINO ACIDS, PROTEINS & CARBOHYDRATES (6 L)** 2.2.1 α-Amino acids and protein: Introduction and Methods of preparations: Strecker synthesis, Gabriel phthalamide synthesis. 2.2.2 Nomenclature and representation of polypeptides. 2.2.3 Introduction Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses) Interconversion: open chain and Haworth	**15**

	forms of monosaccharides with 5 and 6 carbons. 2.2.4 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers and mutarotation **2.3 MOLECULAR REARRANGEMENTS (3 L)** Mechanism and stereochemistry of the following rearrangements 2.3.1 Migration to the electron deficient carbon: Pinacol-pinacolone rearrangement. 2.3.2 Migration to the electron deficient nitrogen: Beckmann rearrangement.	

REFERENCES:

1) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

2) Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

3) Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

4) Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.

5) Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.

6) Chemistry of natural products by Chatwal Anand – Vol I and Vol II

7) Chemistry of natural products by Meenakshi Sivakumar and Sujata Bhat.

8) Lehninger Principles of Biochemistry – David L. Nelson and Michael M. Cox

Heterocyclic Chemistry" – J.A. Joule and K. Mills

PRACTICALS

Course Code 25BUCH5P01	Course Title: Practicals Based on 25BUCH5T01	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Determine molecular properties of compounds using colligative property methods such as the Rast method and understand solution behavior.	L3
CO2	Develop practical skills in chemical kinetics and surface chemistry by determining reaction orders and analyzing adsorption data using graphical and instrumental techniques.	L4
CO3	Apply potentiometric and conductometric techniques to determine solubility, solubility product, and reaction kinetics.	L3
CO4	Determine dissociation constants of amino acids and calculate their isoelectric point by using pH-metric analysis.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	0	2
CO2	3	3	1	0	1	3
CO3	3	3	1	0	0	3
CO4	3	3	1	0	0	3

	I] Non-instrumental:
1	**Colligative properties** To determine the molecular weight of compound by the Rast Method
2	Rast's Macro Method, Determination of Molal Depression Constant
3	**Surface phenomena** To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm -I (Theory, Experiment)
4	To investigate the adsorption of acetic acid on activated charcoal and test the validity of Freundlich adsorption isotherm -II (Calculation, graph and results)
5	Determine the surface tension of liquid by stalagmometer method
6	**Chemical Kinetics** To determine the order of reaction between $K_2S_2O_8$ and KI by the fractional change method- I (Theory, Experiment)
7	To determine the order of reaction between $K_2S_2O_8$ and KI by the fractional change method-II (Calculation, graph and results)
	II] Instrumental:
8	**Potentiometry:** To determine the solubility product and solubility of AgCl potentiometrically using a chemical cell.
9	To determine the concentration of $KMnO_4$ using standard ferrous ammonium sulphate by potentiometric titration.
10	**Conductometry:** To determine the velocity constant of alkaline hydrolysis of ethyl acetate by conductometric method

11	Conductometry determination of equivalent conductance.
12	To determine the strength of a given dibasic acid by Conductometric Titration
13	**pH-metry**: To determine acidic and basic dissociation constants of amino acid and hence to calculate isoelectric point
14	pH Titration of Weak Acid - Determine of pka of Acetic Acid
15	**Colorimetry** To Study the effect of temperature and concentration on the rate of oxidation of potassium iodide by potassium persulphate using colorimeter**.**

Reference books:

1. Practical Physical Chemistry 3rd edition A. M. James and F.E. Prichard , Longman publication
2. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
3. Advanced Practical Physical Chemistry J.B.Yadav,Goel Publishing House
4. Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
5.Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J.Mendham et.al

Course Code 25BUCH5P02	Course Title: Practicals Based on 25BUCH5T02	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Synthesize coordination compounds and understand the principles of complex formation.	L3
CO2	Demonstrate the ability to prepare and characterize transition metal complexes with ligands like oxalate and acetylacetonate.	L4
CO3	Determine the percentage purity of a water-soluble inorganic salt through titrimetric methods	L3
CO4	Detect cations and anions qualitatively using classical wet tests and confirm their presence in mixtures.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	0	0	0	**2**
CO2	3	3	1	0	1	3
CO3	3	3	1	0	0	3
CO4	3	3	1	0	0	3

	I. Inorganic preparations
1	Preparation of Potassium diaquobis-(oxalato)cuprate (II)
2	Preparation of bisacetylacetonatocopper(II)
3	Preparation of ferrous ethylene diammonium sulphate
4	Preparation of tris(ethylene diamine) nickel (II) sulphate
5	Preparation of Chloropentaaminecobalt (III) chloride
	II. Inorganic Quantitative and Qualitative Analysis **A)** Determination of percentage purity of the given water-soluble salt by quantitative method (Any Five salts) **B)** Qualitative detection of cation and/or anion (qualitative analysis by wet tests). (Any Five salts)

Reference Books:

1. **Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.**
2. **Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010., U.N.Dhur & Sons Pvt Ltd .**
3. **Vogel's. Textbook of Macro and Semimicro qualitative inorganic analysis. Fifth edition**

Course Code 25BUCH5P03	Course Title: Practicals Based on 25BUCH5T03	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Explain the fundamental principles behind different separation techniques for solid-solid mixtures.	L2
CO2	Demonstrate the appropriate separation method for given binary mixtures based on physical and chemical properties.	L3
CO3	Conduct laboratory experiments to separate binary mixtures using techniques such as filtration, and sublimation, and analyze the effectiveness of each method.	L4
CO4	Evaluate the industrial and environmental significance of separation processes, such as waste management, water purification, and chemical manufacturing. .	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	2
CO2	3	2	0	0	1	1
CO3	3	3	1	0	1	2
CO4	3	2	0	3	0	3

	I) Separation of Binary solid-solid mixture (15 mixtures)
	Components of Solid-Solid mixture should include water soluble and water Insoluble acids (carboxylic acid), water insoluble phenols (2-naphthol, 1-naphthol), water insoluble bases (nitroanilines), water-soluble neutral (thiourea) and water-insoluble neutral compounds (anilides, amides, m-DNB, hydrocarbons),
	A sample of the mixture 1gm to be given to the student for detection of the physical type of the mixture
	After correct determination of physical type, separation of the binary mixture to be carried out by using microscale technique.
	After separation into component A and component B, the compound to be identified can be decided by examiner.
	After the correct determination of chemical type, the separating reagent should be decided by the student for separation.
	Follow the separation scheme with the bulk sample of the binary mixture.
	After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with m.p.

REFERENCES:

1. Practical organic chemistry – A. I. Vogel
2. Practical organic chemistry – H. Middleton.
3. Practical organic chemistry – O. P. Agarwal

Course Code 25BUCH5TE1	DSE Course Title: Advances in Analytical Chemistry-I	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Explain the concepts of quality, quality control, and quality assurance in analytical chemistry, and apply chemical calculation skills for interconversion of concentration units in laboratory analysis, Determine the percent composition of elements in compounds	L3
CO2	Explain the principles, procedures, and applications of complexometric titrations using EDTA and metallochromic indicators.	L3
CO3	Explain the principles, instrumentation and applications of atomic and molecular spectroscopy techniques, including FES, AAS, and Molecular Fluorescence and Phosphorescence.	L4
CO4	Describe the principles, instrumentation, and applications of HPLC, and HPTLC, and evaluate their advantages and limitations in chemical analysis.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	3
CO2	3	2	0	0	1	3
CO3	3	3	2	0	0	3
CO4	3	3	2	0	0	3

UNIT I	**Introduction To Quality Concepts, Chemical Calculations and Complexometric Titrations** **1.1 Quality in Analytical Chemistry (05 L)** 1.1.1 Concepts of Quality, Quality Control and Quality Assurance, quality control ICH guidelines. 1.1.2 Importance of Quality concepts in Industry 1.1.3 Chemical Standards and Certified Reference Materials; Importance in chemical analysis, Quality of material: Various grades of laboratory reagents **1.2 Chemical Calculations (Numericals and word problems are expected) (03 L)** 1.2.1 Inter conversion of various concentration units. (Conversion of concentration from one unit to another unit with examples) 1.2.2 Percent composition of elements in chemical compounds. **1.3 Complexometric Titrations (07 L)** 1.3.1 Introduction, construction of titration curve 1.3.2 Absolute and conditional formation constants of metal EDTA complexes, Factors affecting the stability of the complexes, Selectivity, Factors enhancing selectivity with examples. Types of EDTA titrations, Advantages and limitations of EDTA. 1.3.4 Metallochromic indicators, theory, examples and applications	**15**

UNIT II	**Optical methods and methods of separation -I (06L)** **2.1 Atomic Spectroscopy: Flame Emission spectroscopy (FES) and Atomic Absorption Spectroscopy (AAS)** 2.1.1 Introduction, Energy level diagrams, atomic spectra, Absorption and Emission Spectra 2.1.2 Flame Photometry and Atomic Absorption Spectroscopy- Principle, Instrumentation. **2.1.3** Quantification methods of FES and AAS – Calibration curve method, Standard addition method and Internal standard method, Applications, Advantages and Limitations. **2.2 Molecular Fluorescence and Phosphorescence Spectroscopy (02 L)** 2.2.1 Introduction and Principle and applications. **2.3 High Performance Liquid chromatography (HPLC) (06 L)** 3 2.3.1 Introduction and Principle, Instrumentation- components with their significance: Solvent Reservoir, Degassing system, Pumps-(reciprocating pumps), Precolumn, Sample injection system, HPLC Columns, Detectors (UV –Visible detector, Refractive index detector) 2.3.2 Qualitative and Quantitative Applications of HPLC **2.4 High Performance Thin Layer Chromatography (HPTLC) (01 L)** 2.4.1 Introduction and Principle - Stationary phase, mobile phase, Sample application and Applications of HPTLC.	**15**

References:

1. A guide to Quality in Analytical Chemistry: An aid to accreditation, CITAC and EURACHEM, (2002)
2. Analytical Chemistry, Gary.D Christan, 5th edition
3. Basic Concepts of Analytical Chemistry, by S M Khopkar, new Age International (p) Limited.
4. High Performance Thin Layer Chromatography by Dr P.D. Sethi, CBS Publisher and Distribution
5. Principles of Instrumental Analysis , 5th Edition, By Skoog, Holler, Nieman.

Course Code 25BUCH5PE1	Course Title: Practicals Based on 25BUCH5TE1	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Apply instrumental techniques such as flame photometry and spectrophotometry for the quantitative determination of metal ions and non-metals in various samples.	L3
CO2	Perform extraction and estimation of biomolecules like lycopene using UV–Visible spectrophotometry and interpret absorbance–concentration relationships.	L4
CO3	Utilize complexometric titration methods for the estimation of metal ions such as magnesium and calcium in industrial and pharmaceutical samples.	L4
CO4	Evaluate the chemical composition and quality of environmental and industrial samples, such as fertilizers and water, through titrimetric and photometric analyses.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	3
CO2	3	3	1	1	0	3
CO3	3	3	0	0	1	3
CO4	3	3	1	3	0	3

	Instrumental
1	To determine potassium content of a Fertilizer by Flame Photometry (calibration curve method).
2	Spectrophotometric estimation of fluoride
3	To extract lycopene from tomato pulp and quantitatively determine its concentration using UV–visible spectrophotometry.
4	To determine amount of aspirin in a given tablet using pH meter
5	To determine the formula of the silver–ammonia complex by potentiometric method.
6	To estimate the percentage purity of paracetamol present in the given sample by using spectrophotometric method.
7	Estimation of sulfanilamide by colorimetry.
	Non- Instrumental
8	Estimation of magnesium content in Talcum powder by complexometry, using standardized solution of EDTA.
9	Analysis of calcium tablets for its calcium content complexometrically.
10	To determine the amount of persulphate in the given sample solution by back titration with standard Fe (II) ammonium sulphate solution.
11	Determination of COD of water sample.

12	To estimate the amount of ferrous ammonium sulphate present in the whole of the given solution being supplied with pure crystals of oxalic acid and approximately 0.05 N solution of potassium permanganate as the link.
13	Determination of chloride in a freshly filtered water sample titrimetrically.
14	Determine the concentration of citric acid in 7up using titration
15	Estimate the percentage ash in milk powder.

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J. Mendham et.al.
3. Industrial Chemistry- B. K.Sharma, Goel publishing House, Meerut.
4. Instrumental methods of analysis by Anand & Chatwal.
5. Principles of instrumental analysis by F. J Holler & J. A Nieman.
7. Spectrophotometric Identification of Organic Compounds by Silverstein.
8. Analytical Chemistry by S. M Khopkar.
9. Food Analysis by S. S. Nielsen.

Course Code: 25BUCH5TE2	Course Title: Industrial and Environmental Chemistry	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Understand industrial chemical processes, reaction principles, and production of basic chemicals like ammonia, nitric acid, and sulphuric acid.	L3
CO2	Evaluate sugar processing and fermentation methods for alcohol production.	L5
CO3	Understand the fundamental concepts of environmental chemistry, including pollution classification, concentration units, environmental segments, and major biogeochemical cycles (C, N, P, S, O).	L2
CO4	Explain the principles of environmental monitoring and analyze key environmental protection laws such as the Environment (Protection) Act, Water Act, Air Act, and Hazardous Waste Management Rules.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	0	3
CO2	3	3	0	1	0	3
CO3	3	1	0	3	0	2
CO4	3	2	1	3	0	3

UNIT I	**1.1 Modern Approach to Chemical Industry (03)** 1.1.1 Introduction, basic requirements of chemical industries, chemical production. 1.1.2 Unit process and unit operations, human resource. 1.1.3 Safety measures, classification of chemical reactions, batch and continuous process. **1.2 Manufacture of Basic Chemicals (06)** 1.2.1 Ammonia: Manufacture of ammonia by modified Haber-Bosch Process. 1.2.2 Nitric acid: Manufacture of nitric acid by Ostwald's process. 1.2.3 Sulphuric acid: Manufacture of sulphuric acid by contact process, **1.3 Sugar Industry (03)** 1.3.1 Introduction, manufacture of cane sugar, extraction of juice. 1.3.2 Purification of juice, sulfidation and carbonation, evaporation, crystallization, separations of crystals, drying refining, grades. **1.4 Fermentation Industry: (03)** 1.4.1 Introduction, importance, conditions favorable for fermentation, Characteristics of enzymes. 1.4.2 Alcohol beverages, Manufacture of beer, manufacture of sprit, manufacture of wines,ethyl alcohol from molasses.	**15**

UNIT II	1. Concepts and Scope of Environmental Chemistry: 2. Introduction, Environmental Pollution and Classification. Units of concentration, Segments of Environment, Biogeochemical cycles of C, N, P, S and O system. 2.2 Environmental Monitoring Law 2.2.1 Introduction, definition types and objectives 2.2.1 Air Quality Monitoring 2.2.3 Water Quality Monitoring 2.2.6 The Environment (Protection) Act, 1986 2.2.7 Water (Prevention and Control of Pollution) Act, 1974 2.2.8 Air (Prevention and Control of Pollution) Act, 1981 2.2.9 Hazardous Waste Management Rules	**15**

References:

1. Industrial Chemistry, B. K. Sharma, Goel publishing House, 18th Ed. (2014)
2. Riegeal's Hand book of industrial chemistry, James A. kent. 9th Ed. CBS publishers
3. Handbook of Industrial Chemistry and Biotechnology, James A. Kent, Tilak V. Bommaraju
4. Scott D. Barnicki, Thirteenth Edition, Springer.
   Shreeve's chemical process industries 5th Edition, G.T. Austin, TATA McGraw-Hill Edition, chemical engineering series.

Course Code 25BUCH5PE2	Course Title: Practicals Based on 25BUCH5TE2	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Demonstrate knowledge of fundamental organic reactions and multi-step syntheses of industrially important compounds, and perform industrial analysis of raw materials, water quality, and pharmaceutical substances as per standard specifications.	L4
CO2	Perform analytical experiments to estimate sugar quality parameters such as invert sugar, sucrose inversion, viscosity, ash content, and sulphite levels in sugar and related samples.	L3
CO3	Analyze heavy metals, metals from drugs.	L4
CO4	Estimate carbohydrates, study carbohydrates w.r.t. different physical parameters.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	1	1	3
CO2	3	2	0	1	1	3
CO3	3	3	1	2	0	3
CO4	3	2	0	0	0	2

1	To perform 2–3-unit process from the following - Nitration, sulphonation, Friedel crafts reaction, esterification, hydrolysis, oxidation, halogenations, chlorosulphonation, reduction and polymerization.
2	Synthesis of common industrial compounds involving two step reactions, e.g. 4-bromo aniline, 3- nitroaniline, sulphanilamide, 4-amino benzoic acid, 4-nitro benzoic acid, dihalobenzenes, nitrohalobenzenes, paracetamol, oils of winter green.
3	Industrial analysis – analysis of common raw materials as per the industrial specifications such as phenol, aniline, formaldehyde, hydrogen peroxide, acetone.
4	Water analysis – Solid content, hardness, COD and other tests as per industrial specifications
5	Limit tests for chlorine, heavy metals, arsenic of drugs.
6	To estimate invert sugars in jaggery using Benedict’s reagent.
7	To study sucrose inversion at different pH levels.
8	To measure viscosity of sugar syrup at various concentrations.
9	To determine ash content in sugar samples.
10	To estimate sulphite content in lime-treated cane juice

11	Legal Case Studies and Landmark Judgments
12	Make biodiesel from vegetable oil
13	Green synthesis of nanoparticles using leaf extract.

MAJOR COURSE CODE: 25BUCH5OJT and 25BUCH6OJT	**(02 Credits)**	**No of lecture in Hrs. 60**

On-Job-Training in Chemistry I and II

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO 1	Apply fundamental chemical knowledge and laboratory techniques to perform routine analytical and experimental tasks in an industrial or research environment	L3
CO 2	Operate chemical instruments, follow standard operating procedures (SOPs), and comply with laboratory safety, quality control, and environmental regulations	L3
CO 3	Analyze experimental data, interpret results, troubleshoot technical issues, and contribute to process optimization or research problem-solving	L5
CO 4	Demonstrate professional work ethics, teamwork, communication skills, and effective documentation while completing assigned industrial or research projects.	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	3	2	1	2	2	-
CO 2	2	1	-	1	3	3
CO 3	2	3	2	3	2	-
CO 4	-	-	-	-	-	3

MAJOR COURSE CODE: 25BUCH5FPR and 25BUCH6FPR	(02 Credits)	No of lecture in Hrs. 60

Field Project in Chemistry III and IV

COURSE OUTCOME

Students will be able to learn OR on completion of this course, students will be able to learn:

CO 1	Apply theoretical knowledge to real-world situations and analyse field-specific challenges	L4
CO 2	Develop practical skills in data collection, analysis, and interpretation related to the project topic	L3
CO 3	Demonstrate problem-solving abilities through innovative and evidence-based approaches	L5
CO 4	Work collaboratively in a team setting while managing time and resources effectively and Compile the reports and outcome of On job Training.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	1	0	0	3
CO 2	2	3	2	0	1	3
CO 3	2	3	1	0	0	3
CO 4	1	2	1	0	3	3

The field project involves applying theoretical knowledge to practical, real-world challenges in a chosen area of study. Students will work on a project relevant to their discipline, incorporating data collection, analysis, problem-solving, and reporting. The project encourages collaboration, critical thinking, and the development of professional skills.

Week 1-2: Orientation and Topic Selection

Overview of field project requirements and objectives.

Guidance on selecting project topics.

Introduction to research methods and tools.

Week 3-4: Literature Review and Proposal Development

Conduct a literature review related to the chosen topic.

Develop a project proposal outlining objectives, methodology, and expected outcomes.

Submit the proposal for approval.

Week 05-06: Data Collection and Fieldwork

Design and execute data collection strategies (e.g., surveys, observations, experiments).

Conduct field visits and gather data as per the approved methodology.

Maintain a fieldwork journal/logbook.

Week 07-08: Data Analysis and Interpretation

Analyze collected data using relevant tools and techniques.

Interpret results to address the project's objectives.

Week 09-10: Report Writing and Presentation Preparation

Prepare a detailed project report including background, methodology, findings, discussion, and

recommendations.

Design and rehearse a presentation of the project outcomes.

Week 11-12: Final Submission and Evaluation

Submit the final project report.

Deliver an oral or poster presentation to peers and faculty.

Receive feedback and final evaluation.

Course Code 25BUCH5TMN	Course Title: Dyes Chemistry	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Describe the historical development, types, properties, and commercial nomenclature of dyes, highlighting significant discoveries and their industrial relevance.	L2
CO2	Classify dyes based on their application and explain their properties, dyes applicability on substrate, and fastness characteristics with relevant industrial examples.	L3
CO3	Explain the relationship between colour and chemical constitution of dyes using various theoretical models and classification of optical brighteners.	L3
CO4	Differentiate between dyes and pigments, describe the properties of organic pigments, and evaluate the ecological and toxicological impacts of dyes used in textiles, food, cosmetics, benzidine and phenylene diamines.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	2
CO2	3	2	0	0	0	3
CO3	3	2	0	0	0	2
CO4	3	2	0	3	0	3

UNIT I	INTRODUCTION TO DYESTUFF CHEMISTRY **1.1** Introduction to dyes 1.1.1 Important landmark in the history of dyes 1.1.2 Natural colouring matter and their limitations: e.g,; Heena, Turmeric, kesar, Chlorophyll, Indigo, Alizarine from roots of madder plants, Logwood. Tyrian purple 1.1.3 Important milestones in the development of synthetic dyes. 1.1.4 Synthetic Dyes: Mauve, aniline Yellow, Congo Red, Indigo, disperse Dye. (structure is not expected) 1.1.5Definition of dyes, Properties i.e. colour, chromophore and auxochrome, Solubility, Linearity, Coplanarity, fastness properties, substantivity, and Economic viability 1.1.6 Explanation of nomenclature of commercial dyes with atleast one example. Suffixes-G, O, R, B, 6B, GK, 3GK, 6GK, L, S Explanation: naming of dyes by colour index (two examples). 1.1.7 Important Dyes industry and Pigments Market Overview. Classification Based on Application Definition, fastness properties & applicability on substrates examples with structures (a) Acid Dyes-Orange II, (b) Basic Dyes-methyl violet (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes-Diazo components:	**15**

	Fast yellow G (e) Mordant Dyes- Alizarin. (f) Vat Dyes- Indanthrene brown RRD.	
UNIT II	2.1 Colour and chemical constitution of dyes 2.1.1 Absorption of visible light, colour of wavelength absorbed, complementary colour. 2.1.2 Relation between colour and chemical constitution. (i) Witt's Chromophore theory (ii) Armstrong theory (quinonoid theory) and its limitations (iii) Valence Bond theory (iv) Molecular Orbital Theory 2.2 Optical Brighteners General idea and important characteristics of optical brighteners, one example each with structure of the following classes: Stilbene, Coumarin. 2.3 Organic Pigments General idea, distinguish between dyes and pigments, important characteristics of organic pigments. 2.4 Ecology and Toxicity of Dyes With reference to the textile dyes, food colours, cosmetic dyes, benzidine, phenylene diamines.	**15**

Reference Books:

1. Synthetic Dyes, M. S. Yadav, Campus Books International, 2nd Edition
2. Synthetic Dyes, G.R. Chatwal, Himalaya Publishing House
3. A Textbook of Synthetic Dyes, O.D Tyagi and M. Yadav, Anmol Publications Pvt Ltd, 1st Edition

Course Code 25BUCH5VSC	Course Title: Chemtech: Vocational excellence in chemical Applications:	Credit 2	No. of Lecture 45

Course Outcomes:

CO1	Develop a comprehensive understanding of packaging science, including its functions, material types, regulatory guidelines, and specialized techniques used in pharmaceuticals and food industries, with emphasis on innovations, preservation methods, and safety considerations.	L4
CO2	Explain and apply modern approaches in pharmaceutical science by integrating knowledge of preservatives, innovative and sustainable packaging solutions, and the use of computational tools and machine learning techniques for molecular modeling and drug discovery using platforms such as DeepChem, RDKit, Chemprop, and AutoDock in compliance with global safety regulations.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	0	3
CO2	3	3	3	2	1	3

UNIT I	**1.1** Introduction to Packaging Science (**Lectures 02)** **1.1.1** Fundamentals of Packaging – Functions, classification, and importance. **1.1.2** Types of Packaging Materials – Glass, plastic, metal, paper, and biodegradable options. **1.2** Packaging of Drugs & Medicines **(Lectures 03)** **1.2.1** Pharmaceutical Packaging Materials – Blister packs, ampoules, vials, strip packaging. **1.2.2** Primary, Secondary & Tertiary Packaging – Role and selection criteria. **1.2.3** Sterile Packaging & Tamper-Evident Seals – Techniques and materials. **1.3** Food Packaging & Preservation **(Lectures 05)** **1.3.1** Materials for Food Packaging – Plastics, glass, metals, bio-based materials. **1.3.2** Food Preservation Techniques – Vacuum packaging, modified atmosphere packaging (MAP). **1.3.3** Role of Preservatives in Food Packaging – Natural vs. synthetic preservatives. **1.3.4** Food Packaging Safety & Regulations – FDA, FSSAI, and global standards. **1.4** Preservative Packaging & Shelf-Life Enhancement **(02)** **1.4.1** Chemical & Natural Preservatives – Mechanism of action in food and pharmaceuticals.	**15**

	1.4.2 Sustainable & Eco-Friendly Packaging – Biodegradable polymers, edible coatings. **1.5** Molecular Modeling & Drug Discovery **(03)** **1.5.1** **Deep Chem**: Open-source toolkit for deep learning in drug discovery and materials science. **1.5.2** **RDKit**: Cheminformatics toolkit for molecule handling and descriptor generation. **1.5.3** **Chemprop**: Machine learning for molecular property prediction using graph neural networks. **AutoDock + AI models**: Used for molecular docking with AI-based optimization	

Reference Books:

1. Fundamentals of Packaging Technology– Walter Soroka
2. Materials for Advanced Packaging – Daniel Lu, C.P. Wong
3. EU Guidelines for Packaging – EudraLex Vol. 4 Annex 1
4. Pharmaceutical Packaging Technology – Edited by D.A. Dean, E.R. Evans, I. Hal
5. Food Packaging: Principles and Practice – Gordon L. Robertson
6. Natural Food Additives, Ingredients and Flavourings – D. Baines & R. Sea

Course Code 25BUCH5VSC	VSC Practical Course Title: Chemtech: Vocational excellence in chemical Applications	Credit 2	No. of Lecture45

Course Outcomes:

CO3	Perform analytical and characterization techniques to determine preservative concentrations, evaluate chemical compatibility and extractables in pharmaceutical packaging materials, classify packaging types, and analyze industrial case studies to ensure quality, safety, and regulatory compliance in drug packaging.	L4
CO4	Evaluate the physicochemical and thermal properties of pharmaceutical packaging materials through tests such as water absorption, density, corrosion, surface pH, moisture, ash content, and thermal resistance to assess their quality, stability, and suitability for drug packaging applications.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	3	1	1	1	3
CO4	3	3	1	2	0	3

1	Determination of preservative concentration using UV visible spectrophotometer.
2	To classify drug packages into primary, secondary, and tertiary categories.
3	Case Study Reports – Analysis of existing packaging solutions. (Mandatory)
4	To study the chemical compatibility of packaging materials (glass, plastic, aluminum) with model drug substances.
5	To analyze extractable substances from plastic or rubber stoppers used in primary packaging.
6	Industrial visit (Mandatory)
7	Polymers Testing: To identify different plastics
8	To identify given packaging materials on the basis of physical and chemical test
9	Water absorption test/COBB's test
10	To identify plastics by density
11	To study chemical compatibility of given packaging materials (corrosion test).
12	To study the surface pH of packaging materials by pH meter
13	To study the moisture content of given packaging materials
14	To study the Ash content of given packaging materials
15	To determine the thermal resistance of given packaging materials. (Thermal shock test).

References:

1) Beckett & Stenlake's Practical Pharmaceutical Chemistry, Vol II – By A.H. Beckett & J.B. Stenlake *(Covers UV-visible spectrophotometry and pharmaceutical assays)*
2) Instrumental Methods of Chemical Analysis – By B.K. Sharma or G.R. Chatwal *(Good for UV-Vis spectroscopy basics and applications)*
3) ICH Guidelines Q6A/Q3B – For preservative content and analytical method validation.

Semester VI

Course Code 25BUCH6T01	Course Title: Advances in Physical Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Understanding electrochemistry, evaluating electrodes and cells, explaining the types of electrodes.	L3
CO2	Classify polymers, discuss their properties, polymer reaction mechanisms, and polymer applications.	L3
CO3	Understanding the foundation of Quantum mechanics, wave particle duality and quantum concepts, quantum mechanical operators.	L
CO4	Discuss fundamentals of NMR, instrumentation and experimental techniques. Explain fundamentals of ESR spectroscopy, Hyperfine splitting, instrumentation.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	0	3
CO2	3	2	0	0	0	3
CO3	3	1	0	0	0	2
CO4	3	2	1	0	0	3

UNIT I	**1.1 ELECTROCHEMISTRY** **1.1.1 Activity and Activity Coefficient:** Lewis concept, ionic strength, Mean ionic activity and mean ionic activity coefficient of an electrolyte, expression for activities of electrolytes. Debye-Huckel limiting law (No derivation). **1.1.2 Classification of cells:** Chemical cells and concentration cells. chemical cells with and without transference, electrode concentration cells, Electrolyte concentration cells with and without transference (derivations are expected) **1.2 APPLIED ELECTROCHEMISTRY** **1.2.1 Polarization**: Concentration polarization and it's elimination **1.3 POLYMERS** **1.3.1: Basic terms and Classification of polymers:** Classification based on source, structure, thermal response and physical properties. **1.3.2 Molar masses of polymers:** Number average, Weight average, Viscosity average molar mass, Monodispersity and Polydispersity **1.3.3 Light Emitting Polymers:** Introduction, Characteristics, Method of preparation and applications. **1.3.4 Commercial polymer:** Synthesis of polymer, how to scale up and energy requirement of the process.	**15**
UNIT II	**2.1 BASICS OF QUANTUM CHEMISTRY** 2.1.1 **Classical mechanics**: Introduction, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect. 2.1.2 **Quantum mechanics:** Introduction, Planck's theory of quantization, wave particle duality, de-Broglie's equation, Heisenberg's uncertainty principle. Progressive and standing waves- Introduction, boundary conditions, Schrodinger's time independent wave equation (No derivation expected), interpretation and properties of wave function, State function and its significance, Concept of operators - definition, addition, subtraction and multiplication of operators, commutative and non-commutative operators, linear operator, Hamiltonian operator.	**15**

	Applications of Quantum Chemistry. **2.2 NMR-NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY** **2.2.1 Principle**: Nuclear spin, magnetic moment, energy levels, Larmor precession, Relaxation processes in NMR (spin-spin relaxation and spin - lattice relaxation). **Instrumentation**: NMR Spectrometer **2.3 ELECTRON SPIN RESONANCE SPECTROSCOPY** **2.3.1 Principle**: fundamental equation, hyperfine splitting. **Instrumentation**: ESR spectrometer, ESR spectrum of hydrogen, deuterium and CH_3 free radical. **Note: Numerical and Word Problems are Expected from All Units**	

Reference Books:

1. Modern Electrochemistry, J.O. M Bockris & A. K. N. Reddy, Maria Gamboa–Aldeco2nd Edition,1st Indian reprint,2006 Springer
2. Fundamental of Molecular Spectroscopy, 4th Edn., Colin N Banwell and Elaine M McCash Tata McGraw Hill Publishing Co. Ltd. New Delhi, 2008.
3. Physical Chemistry, G.M. Barrow,6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
4. The Elements of Physical Chemistry, P.W. Atkins,2nd Edition, Oxford Universtity Press Oxford.
5. Principles of Physical Chemistry B. R. Puri, L. R. Sharma, M. S. Pathania, VISHAL PUBLISHING Company, 2008.
6. Text book of Polymer Science, Fred W Bilmeyer, John Wiley & Sons (Asia)Ple. Ltd., Singapore,2007.
7. Polymer Science, V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, New Age

Course Code 25BUCH6T02	Course Title: Advances in Inorganic Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Analyze the limitations of VBT and apply CFT to explain metal-ligand interactions in coordination complexes of various geometries (tetrahedral to octahedral) with respect to distortion, splitting of d orbital, calculation of CFSE and Effect of CFSE	L4
CO2	Apply MOT to analyze bonding in coordination compounds by constructing molecular orbital diagrams (especially for ML_6 type complexes), identifying suitable metal and ligand orbitals, and evaluating the effect of π-bonding using representative complexes.	L4
CO3	Understand and analyze the reactivity patterns of metal complexes, including ligand substitution mechanisms and hydrolysis reactions, and interpret the electronic spectra of transition metal complexes by applying selection rules, term symbols, and electronic transitions.	L4
CO4	Explain the structure, bonding, and synthesis of main group organometallic compounds, and analyze their role in different types of catalysis with emphasis on the mechanism of Wilkinson's catalyst in homogeneous hydrogenation reactions	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	0	0	0	3
CO2	3	3	1	0	0	3
CO3	3	3	1	0	0	3
CO4	3	3	0	1	0	3

UNIT I	1.1 Theories of the metal-ligand bond (I) (11L) 1.1.1 Limitations of Valence Bond Theory. 1.1.2 Introduction to Crystal Field Theory. 1.1.3 Splitting of d orbitals in octahedral, square planar and tetrahedral crystal fields. 1.1.4 Distortions from the octahedral geometry : (i) effect of ligand field and (ii) Jahn-Teller distortions. 1.1.5 Crystal field splitting parameters Δ. 1.1.6 Crystal field stabilization energy(CFSE), calculation of CFSE for octahedral complexes. 1.2 Molecular orbital Theory for coordination compounds. (4L) 1.2.1 Identification of the central metal orbitals and their symmetry suitable for formation of bonds with ligand orbitals. 1.2.2 Construction of ligand group orbitals. 1.2.3 Construction of -molecular orbitals for an ML6 complex. 1.2.4 Examples like $[FeF_6]^{-4}$, $[Fe(CN)_6]^{-4}$, $[FeF_6]^{-3}$, $[Fe(CN)_6]^{-3}$, $[CoF_6]^{-3}$, $[Co(NH)_6]^{+3}$	**15**

UNIT II	2.1 Reactivity of metal complexes. (4L) 2.1.1 Types of reactions in metal complexes. 2.1.2 Inert and labile complexes: correlation between electronic configurations and lability of complexes. 2.1.3 Ligand substitution reactions: Associative and Dissociative mechanisms. 2.1.4 S_N1CB mechanism. 2.1.5 Medicinal applications of EDTA. 2.2 Electronic Spectra. (5L) 2.2.1 Origin of electronic spectra 2.2.2 Types of electronic transitions in coordination compounds. 2.2.3 Selection rules for electronic transitions. 2.2.4 Electronic configuration and electronic micro states, Terms and Term symbols for transition metal ions. 2.2.5 Determination of Terms for p^2 and d^1 electronic configurations. 2.3 Organometallic Compounds of main group metal (6L) 2.3.1 General characteristics of various types of organometallic compounds. 2.3.2 General synthetic methods of organometallic compounds: (i) Oxidative-addition, (ii)Metal-metal exchange(transmetallation), (iii) Carbanion-halide exchange, (iv) Metal-hydrogen exchange(metallation) (v) Methylene- insertion reactions. 2.3.3 Catalysis: Comparison between homogeneous and heterogeneous catalysis, Basic steps involved in homogeneous catalysis, Mechanism of Wilkinson's catalyst in hydrogenation of alkenes, applications of catalysis**.**	**15**

Reference Books:

1. Geoffrey A. Lawrance Introduction to Coordination Chemistry John Wiley & Sons
2. R. K. Sharma Text Book of Coordination Chemistry Discovery Publishing House
3. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers,
4. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, Twigg ,
5. Mechanisms of Inorganic and Organometallic Reactions Publisher: Springer
6. R.K. Sharma Inorganic Reaction Mechanisms Discovery Publishing House
7. M. L. Tobe Inorganic Reaction Mechanisms Publisher Nelson, 1972
8. Cotton, Wilkinson, Murillo and Bochmann, Advanced Inorganic Chemistry, 6 th Edition..
9. H.W. Porterfield, Inorganic Chemistry, Second Edition, Academic Press, 2005 8
10. Purecell, K.F. and Kotz, J.C., Inorganic Chemistry W.B. Saunders Co. 1977.

Course Code 25BUCH6T03	Course Title: Advances in Organic Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Develop a comprehensive understanding of molecular chirality, symmetry elements, and stereochemical principles, including stereoselectivity, stereospecificity, and topicity, to analyze and predict the stereochemical behavior of organic molecules.	L4
CO2	Analyze the stereochemical outcomes of substitution, elimination, and addition reactions, demonstrating an understanding of reaction mechanisms and their influence on stereoselectivity and stereospecificity. molecules.	L4
CO3	Develop a fundamental understanding of UV-Visible, Mass, IR, and PMR spectroscopy, including their principles, spectral characteristics, and applications in structural elucidation of organic compounds.	L2
CO4	Apply spectroscopic techniques (UV-Vis, IR, Mass, and NMR) to analyze and elucidate the structures of organic compounds..	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	0	0	0	3
CO2	3	3	0	0	0	3
CO3	3	2	1	0	0	2
CO4	3	**3**	1	0	0	3

UNIT I	**1.1 Stereochemistry (15L)** 1.1.1 Molecular chirality and elements of symmetry. 1.1.2 Chirality of compounds without a stereo genic center: cummulenes and biphenyls. 1.1.3 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de) , Topicity : enantiotopic and diasterotopic atoms, groups and faces. 1.1.4 Stereochemistry of – i) Substitution reactions: SNi (reaction of lcohol with thionyl chloride) ii) Elimination reactions: E2–Base induced dehydrohalogenation of 1-bromo-1,2- diphenyl propane. iii) Addition reactions to olefins: a) bromination (electrophilic anti-addition) b) syn hydroxylation with OsO_4 and $KMnO_4$ c) epoxidation followed by hydrolysis.	**15**

UNIT II	**2.1 Spectroscopy** **2.1.1 UV – Visible spectroscopy: Basic theory.** **2.2. IR Spectroscopy:** Basic theory, nature of IR spectrum, selection rule, fingerprint region. **2.3 PMR Spectroscopy**: Basic theory of PMR, nature of PMR spectrum, chemical shift (δ unit), solvents used. Factors affecting chemical shift: (i) inductive effect (ii) anisotropic effect, Spin-spin coupling and coupling constant. Application of deuterium exchange technique. 2.3.1 Spectral characteristics of organic compounds containing various functional groups. **2.3 Mass spectrometry:** Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, nitrogen rule, rule of 13 for determination of empirical formula and molecular formula. Problems of structure elucidation of simple organic compounds using individual or combined use of UV-Vis, IR, Mass and NMR spectroscopic technique are expected	**15**

Reference Books:

1. L. Eliel , stereochemistry of carbon compounds, Tata McGraw Hill
2. Stereochemistry P.S.Kalsi , New Age International Ltd.,4th Edition
3. Stereochemistry by Nassipuri.
4. Organic spectroscopy (Second edition),Jag Mohan ,Narosa publication
5. Spectroscopy, Pavia, Lampman, Kriz,Vyvyan.
6. Introduction to spectroscopy (third edition), Pavia ,Lampman,Kriz,john vondeling,Emily Barrosse.
7. Organic chemistry Paula Y. Bruice, Pearson education.

Absorption spectroscopy of organic molecules by V.M.Parikh.

Course Code 25BUCH6IKS	Course Title: Indian Knowledge System in Chemical Sciences	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Explain the origin and evolution of Alchemy and Rasayana, and evaluate ancient Indian contributions to chemistry and metallurgy through literary and archaeological evidence.	L5
CO2	*Describe* ancient Indian developments in textile and glass technologies and *analyze* historical knowledge of poisons, abusive substances, and explosives.	L4
CO3	Summarize the contributions of Acharya Nagarjuna, Acharya P. C. Ray, Prof. Sadhan Basu, Prof. C. N. R. Rao, and Prof. H. J. Arniker to various branches of chemistry.	L2
CO4	*Recognize* the pioneering research of Dr. Yusuf Khwaja Hamid, Dr. Asima Chatterjee, Dr. Shanti Swarup Bhatnagar, Prof. S. R. Gadre, J. C. Ghosh and Prof. B. Viswanathan in advancing modern chemical sciences.	L2

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	0	0	2
CO2	3	2	0	1	0	2
CO3	3	1	0	0	0	1
CO4	3	1	0	0	0	1

UNIT I	**1: Ancient Indian Chemistry** **1.1. From Alchemy to Chemistry:** Origin of Alchemy, Benefits of Rasayana, Early Chemical Techniques, Technology and Arts, Different Areas of Development in Ancient India: Glass Making (Literary Sources, Foreign Travellers' Account, Archaeological Evidences), Paints and Dyes, Perfumes and Cosmetics, Chemicals in Ancient India, Paper and Ink Making, Alcoholic Liquors. (Ref- 1,2,3,4,5,6,7,9) **1.2**. Introduction, Metallurgy and working of metals: Zinc (Zn), Mercury (Hg), Gold (Au), Silver (Ag), Copper (Cu), Bronze and Brass, and iron (Fe), Tinning and alloying, enamelling, gunpowder, saltpetre, mineral acid, alum and green vitriol (Ref- 8, 9,10, 11,12,13) **1.3. Textile Technology in Ancient India:** Cotton (natural cellulose fiber), Silk, Wool (natural protein fibers), Bast and leaf fibers, Mridhudhautadhupitambaram (meaning a practice of fumigating the fabric with incense smoke before use as a part of the finishing process), Sitadhautavasanayugala (bleached white – a finishing process); Suchhastah, Sutradharah (needle and thread – tools for (15-21)	**15**

	1.4. Glass Industry in Ancient India: Glass: Different glass forms and their suitability. **1.5. Poisons used in ancient times & their anti-dotes**, Abusive Drugs and Explosives in Ancient India: Snake poison, chemical poisons etc. Classification of poisonous plants based on their chemical constitution, Historical murders and suicides due to poison, substance of abuse: Marijuana (Hemp), Coccaine, Gun powder (barood). (21-29)	
UNIT II	2. General history of Chemical science: Indian Pioneers in Chemical sciences: 2.1. Acharya Nagarjuna, Indian alchemist and pioneer of Rasashastra. Contributions to Rasashastra, including extraction and purification of metals. Overview of his major works like *Rasaratnākara*, chemical techniques such as distillation, calcination, sublimation, and his role in integrating chemistry with medicine and philosophy. (1-2) 2.2. Acharya P. C. Ray: Area of research: Acharya P. C. Ray established the first modern research in Chemistry and is regarded as the father of chemical science in India. He published around 150 research articles during his lifetime. He discovered the stable compound mercurous nitrite in 1896 and established Bengal chemical and pharmaceutical works Ltd, India's first pharmaceutical company in 1901. 2.3. Prof. Sadhan Basu Area of research: Bio-Physical Chemistry, Viscosity of DNA Optimum pH for enzyme activity, Quantum Chemistry, Free electron molecular orbital (MO) theory, Hückel theory, Tomonaga gas model, Orientation of substituents in aromatic compounds, Free electron theory of Diels–Alder reaction. 2.4. Prof. C. N. R. Rao: Area of research: Prof. C. N. R. Rao is a leading Indian scientist in the field of solid state and materials chemistry. His major area of research comprises solid state chemistry, , transition metal oxides and other extended inorganic solids, inorganic-organic hybrid materials, nanomaterials, Two-dimensional materials and generation of hydrogen by photocatalysis, superconductivity, Atomic layer deposition and pulsed laser deposition 2.5. J.C. Ghosh Area of research: Strong Electrolytes, Fisher-Tropsch Reaction,. Photochemistry, Raman Spectroscopy. 2.6. Prof. H. J. Arniker: Area of research: Prof. H. J. Arniker was worked in the field of Radiochemistry and Allied sciences. He was applied Neutron activation analysis in the various fields of chemical science. 2.7. Dr. Yusuf Khwaja Hamid: Area of research: Dr. Yusuf Khwaja Hamid is a Polish born Indian scientist, the chairman of Cipla, a generic pharmaceuticals company founded by his father Kwaja Abdul Hamied in 1935. He is also an elected fellow of the Indian National Science Academy. 2.8. Dr. Asima Chatterjee: Area of research: Dr. Asima Chatterjee was an Indian organic chemist noted for her work in the fields of organic chemistry and phytomedicine. Her most notable work includes research on vinca alkaloids, the development of anti-epileptic drugs and development of anti-malarial drugs. 2.9. Dr. Shanti Swarup Bhatnagar	**15**

	Area of research: Specialized in Colloid Chemistry, Magneto-chemistry, and industrial research applications, Pioneered research on emulsions, colloids, and industrial oils, Contributed significantly to the development of techniques for drilling crude oil in India, Worked on natural products and industrially useful chemical processes. Role in establishing 12 national laboratories in India, such as National Chemical Laboratory (NCL), National Physical Laboratory (NPL), and others. 2.10. Prof. S. R. Gadre: Area of research: Prof. S. R. Gadre is an Indian scientist working in computational quantum and theoretical chemistry. He has authored authors over 200 publications. 2.11 Prof. B. Viswanathan Area of Research: Scientist from IIT Madras, has extensively contributed to heterogeneous catalysis, fuel cell technology, photocatalysis, and materials chemistry. His research includes the design and synthesis of extended inorganic solids, inorganic–organic hybrid materials, nanomaterials, and two-dimensional materials. He has made significant advancements in hydrogen generation through photocatalysis, studies on superconductivity, and thin-film growth techniques such as Atomic Layer Deposition (ALD) and Pulsed Laser Deposition (PLD).	

Reference Books:

[1] Introduction to Indian Knowledge System, unit_1_c_Vedic_Metallurgy_Notes_English.pdf

[2] Ancient glass and india, S. N. Sen and Mamata Chaudhurl, Indian National Science Academy New Delhi

[3] Alok Kumar Kanungo and Laure Dussubieux, indigenous glass manufacture in India: an ethnographic approach, journal of glass studies, volume 64, 225-247.

[4] M.L. Gulrazani, and Deepti Gupta. *Natural dyes and their application to textiles,* Department of Textile Technology, IIT, New Delhi, 1992.

[5] A Review on Historical Earth Pigments Used in India's Wall Paintings, Anjali Sharma and Manager Rajdeo Singh, https://doi.org/10.3390/heritage4030112

[6] B. Mahadevan, Bhat, Vinayak Rajat, Pavana R.N. Nagendra, *Introduction to Indian Knowledge System: Concepts and Applications,* 2022, 1st Edition, PHI Learning Pvt. Ltd.

[7] Preparation and testing of perfume as described in Brhatsamhita, Sachin A Mandavgane, PP Holey & J Y Deopujari, Indian Journal of Traditional Knowledge Vol. 8(2), April 2009, pp. 275-277, https://www.researchgate.net/publication/298350403_Preparation_and_testing_of_perfume_as_described_in_Brhatsamhita

[8] Introduction to Indian Knowledge System, https://mjcollege.kces.in/pdf/download_documents/study_material_iks_sem_2/unit_1_c_Vedic_metallurgy_ppt_English.pdf

[9] Chemistry and Metallurgy in India From Alchemy to chemistry, NCERT, https://ncert.nic.in/textbook/pdf/keks108.pdf

[10] Zhao M, Li Y, Wang Z. Mercury and Mercury-Containing Preparations: History of Use, Clinical Applications, Pharmacology, Toxicology, and Pharmacokinetics in Traditional Chinese Medicine. Front Pharmacol. 2022 Mar 2;13:807807. doi: 10.3389/fphar.2022.807807. PMID: 35308204; PMCID: PMC8924441., (Mercury) https://pmc.ncbi.nlm.nih.gov/articles/PMC8924441/#:~:text=Application%20History%20of%20Mercury%20in,many%20diseases%20and%20delay%20death.

[11] The Vision of NEP 2020 Integrating Bharatiya Knowledge System in Chemistry Textbooks Vidya Bharati Uchcha Shiksha Sansthan (Page no 32-66) copper and Alloy

[12] History Of Chemistry in Ancient And Medieval India, edited by P. Ray, Indian Chemical Society, Calcutta, 1956. **https://ia601309.us.archive.org/27/items/in.ernet.dli.2015.49766/2015.49766.History-Of-Chemistry-In-Ancient-And-Medieval-India-1956_text.pdf (**Tinning and alloying, enamelling, gunpowder, saltpetre, mineral acid, alum and green vitriol)

[13] Timothy May. Review of Khan, Iqtidar Alam. Gunpowder and Firearms: Warfare in Medieval

India. H-War, H-Net Reviews. August, 2006. https://www.h-net.org/reviews/showpdf.php?id=12189 (Gunpowder)
[14] Moti Chandra, *Indian costumes and textiles from the eighth to the 12th century*, Journal of Indian textile history, vol.5, 1960 pp.1-41.
[15] M.L. Gulrazani, and Deepti Gupta. *Natural dyes and their application to textiles,* Department of Textile Technology, IIT, New Delhi, 1992.
[16] Infinity Foundation, Textile Technologies: a Historical Perspective" by Charu Smita Gupta.
[17] S. M. Vaidya, P. V. Kulkarni, *Writing In Ancient India And Writing Materials - In the Study of Manuscripts*, International Journal of Innovative Research and Advanced Studies, 3(10), 240, 2016.
[18] Subbarayappa, B.V. (Ed.) 1999.. A Note on Glass in India. In *Chemistry and Chemical Techniques in India* (Ed.) By B.V. Subbarayappa. Vol IV Part 1. New Delhi: Centre for Studies in Civilization. Pp. 323-336 (Glass)
[19] Glass Beads in Ancient India and Furnace- Wound Beads at Purdalpur: An Ethnoarchaeological Approach, ALOK KUMAR KANUNGO, Asian Perspectives, VoL 43, No.1, University of Hawai'j Press.
[20] Indian Knowledge System: A study of Ancient Indian Chemistry of Glass, Shivani Banerjee, International Journal of Advance and Innovative Research, Vol 11, Issue 1 (III) March 24, page no 51-54.
[21] Dilip Kumar Goswami , Poison as Discussed by Susruta, The Father of Surgery, Biomedical Science and Clinical Research, Vol 1, issue 1, 18-20.
[22] M. B. Ghiya, P. R. Chothani. *Treatment of Poison in Ancient India.* Ann. Case Rep Clin Stud. 2023; 2 (2), 1-5.
[23] A. A. Pappas, N. A. Massoll, D. J. Cannon, *Toxicology: past, present, and future,* Ann. Clin. Lab. Sci. 1999, 29(4), 253-62.
[24] S. Basu, *The History of Forensic Science in India*, Routledge Publisher 2021.
[25] B. Sharma, V. K. Gupta, *Forensic Applications of Indian Traditional Toxic Plants and their Constituents*, Forensic Research & Criminology International Journal, 4(1) 2017.
[26] M. B. Ghiya, P. R. Chothani. *Treatment of Poison in Ancient India.* Ann. Case Rep Clin Stud. 2023; 2 (2), 1-5.
[27] A. A. Pappas, N. A. Massoll, D. J. Cannon, *Toxicology: past, present, and future,* Ann. Clin. Lab. Sci. 1999, 29(4), 253-62.
[28] S. Basu, *The History of Forensic Science in India*, Routledge Publisher 2021.
[29] B. Sharma, V. K. Gupta, *Forensic Applications of Indian Traditional Toxic Plants and their Constituents*, Forensic Research & Criminology International Journal, 4(1) 2017.

Unit II:

[1] Ray, Prafulla Chandra. History of Hindu Chemistry (Vol. I & II). Calcutta: Bengal Chemical & Pharmaceutical Works, 1902–1909.
[2]"Research Evidences of Rasashastra, https://drive.google.com/file/d/1P7jBPDadO3lvx8ylYFi8veXktx0YDVO/view?usp=sharing
[3] ACHARYA PRAFULLA CHANDRA RAY: SOME IMPORTANT CONTRIBUTIONS IN CHEMICAL RESEARCH Mausumi Roychowdhury, https://journal.panchakotmv.ac.in/published/paper_full_text/168421669126095.pdf
[4] History Of Chemistry in Ancient And Medieval India, edited by P. Ray, Indian Chemical Society, Calcutta, 1956. https://ia601309.us.archive.org/27/items/in.ernet.dli.2015.49766/2015.49766.History-Of-Chemistry-In-Ancient-And-Medieval-India-1956_text.pdf
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[6]https://chemistry.as.miami.edu/_assets/pdf/murthy-group/kankan-bhattachrayya-pchem-in-india.pdf
[7] Prof. C.N.R. Rao: A Life Dedicated to Science, Raghunandan Prasad Chamoli, International Journal of Humanities Social Sciences and Education (IJHSSE) Volume 2, Issue 11, November 2015, PP 95-99 ISSN 2349-0373 (Print) & ISSN 2349-0381 (Online)
[8] S. Natarajan (2009). *In Celebration of the 75th Birthday of Professor C. N. R. Rao. , 4(6), 780–781.* doi:10.1002/asia.200900160
[9] H J Arnikar, Nuclear Chemistry, (revised Fourth Edition) New Age International Publishers, New Delhi, https://toaz.info/doc-view-3

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[12] Asima Chatterjee by S C Pakrashi https://share.google/4VcuPYSHCoHhEfuIO (Dr Asima Chatterjee)
[13] https://www.hercircle.in/engage/get-inspired/achievers/meet-dr-asima-chatterjee-one-of-india39s-famous-women-doctorates-4109.html (Dr Asima Chatterjee)
[14] A Tribute to Prof. Asima Chatterjee, ARKIVOC 2003 (ix) 1-3, Shibnath Ghosal, Volume 2003, Issue 9, Commemorative Issue in Honor of Prof. Asima Chatterjee on the occasion of her 85th anniversary, pp. 1-3, DOI: http://dx.doi.org/10.3998/ark.5550190.0004.90, https://quod.lib.umich.edu/a/ark/5550190.0004.901?rgn=main;view=fulltext
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[17] https://www.csirhrdg.res.in/Home/Index/1/Default/2678/65
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[19] https://research.com/u/shridhar-r-gadre
[20] Quantum Chemical Investigations on Molecular Clusters, Shridhar R. Gadre, Sachin D. Yeole, and Nityananda Sahu, Chemical Reviews 2014 114 (24), 12132-12173, DOI: 10.1021/cr4006632
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[23]Sir J. C. Ghosh – A pioneer in photochemical and photobiological researches, K. K. Rohatgi-Mukherjee, Current Science, Vol. 68, No. 10 (25 May 1995), pp. 1068-1072 (5 pages), Current Science Association
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PRACTICALS

Course Code 25BUCH6P01	Course Title: Practicals Based on 25BUCH6T01	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	*Determine* the order of a chemical reaction graphically and *calculate* the specific rate constant from experimental data.	L4
CO2	*Estimate* the molecular weight of polyvinyl alcohol (PVA) using viscosity measurements	L3
CO3	*Analyze* ionic reactions and redox processes by potentiometric and conductometric titrations to estimate ions or acid mixtures accurately.	L4
CO4	*Quantify* Fe(III) ions by colorimetric analysis through complex formation with salicylic acid using the static method.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	0	0	3
CO2	3	2	0	0	0	2
CO3	3	3	1	0	0	3
CO4	3	**2**	0	0	0	3

	I] Non-instrumental:
	Chemical Kinetics
1	To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant. (No fractional order)
2	To interpret the order of reaction graphically from the given experimental data and calculate the specific rate constant-II (No fractional order)
	Viscosity
3	To determine the molecular weight of high polymer poly vinyl alcohol (PVA) by viscosity measurement.
4	To determine the radius of a glycerol molecule by viscosity measurements.
5	To determine solubility of given organic solid in water and heat of solution at particular temperature range.
6	To Construct the Phase diagram of two component system-Diphenyl amine-benzophenone by cooling curve method and hence determination of eutectic temperature and eutectic composition
7	Determination of Oxalic Acid and Sulphuric Acid From their Mixture
	II] Instrumental
	pH –Metry
8	Verification of Henderson-Hasselbalch Equation using Solutions of a weak acid and its salt (conjugate base)
9	To determine the concentration and dissociation constant of given dibasic acid solution using pH metry.
	Potentiometry
10	To determine the amount of iodide, bromide and chloride in the mixture by potentiometric titration with silver nitrate.
11	To determine the number of electrons in the redox reaction between ferrous ammonium sulphate and cerric sulphate potentiometrically.
12	To determine the concentration and dissociation constant of given dibasic acid solution potentiometrically.
	Conductometry

13	To titrate a mixture of weak acid and strong acid against strong base and estimate the amount of each acid in the mixture conductometrically.
14	Determination of Critical Micellar Concentration (CMC) by conductivity method.
	Colorimetry
15	To estimate the amount of Fe(III) in the complex formation with salicylic acid by Static Method.

Course Code 25BUCH6P02	Course Title: Practicals Based on 25BUCH6T02	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Perform the synthesis of coordination compounds and analyze their composition and properties through established inorganic preparation techniques.	L4
CO2	Demonstrate the use of green chemistry principles in the synthesis of metal complexes using environmentally friendly reagents and methods.	L3
CO3	Identify the cationic and/or anionic components of inorganic salts using quantitatively and interpret their chemical behaviour.	L4
CO4	Identify the cationic and/or anionic components of inorganic salts using qualitative wet tests and interpret their chemical behaviour.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	0	0	1	3
CO2	3	2	0	3	1	3
CO3	3	3	1	0	0	3
CO4	3	1	0	0	0	3

I	**Inorganic preparations**
1	Preparation of Tris(acetylacetonato)iron(III)
2	Green synthesis of bis(dimethylglyoximato) nickel(II) complex using nickel carbonate and sodium salt of dmg .
3	Preparation of potassium Trioxalato aluminate(III) complex.
4	Preparation of potassium Tetraammine Copper (II) Sulphate complex.
5	Preparation of Manganese (III) Acetyl acetonate complex
II	**Inorganic Quantitative and Qualitative Analysis**
	A) Determination of percentage purity of the given water-soluble salt by quantitative method (Any Five salts) **D)** Qualitative detection of cation and/or anion (qualitative analysis by wet tests). (Any Five salts)

Course Code 25BUCH6P03	Course Title: Practicals Based on 25BUCH6T03	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Perform organic synthesis reactions such as etherification, bromination, Schiff base formation, and acetylation to prepare derivatives from β-naphthol, acetanilide, aniline/p-toluidine, and hydroquinone.	L3
CO2	Analyze the reaction mechanisms, purity, and yields of the synthesized organic derivatives, and evaluate factors influencing reaction efficiency and product formation.	L5
CO3	Explain the fundamental principles behind different separation techniques for solid- liquid, and liquid-liquid mixtures.	L2
CO4	Apply suitable separation techniques for binary mixtures by interpreting their physical and chemical properties, performing laboratory procedures such as filtration, distillation and assessing the broader industrial and environmental relevance of these processes.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	1	3
CO2	3	3	1	0	3	3
CO3	3	1	0	0	3	2
CO4	3	3	0	2	1	3

I	**Organic Preparations:** 1. β-naphthol → Methyl Ether derivative (Using dimethyl sulphate) 2. Acetanilide → p-bromoacetanilide derivative 3. Aniline/ p-toluidine → Schiff base with benzaldehyde 4. Hydroquinone/beta naphthol → Acetyl derivative Note: During Practical Examination, only preparation will be evaluated.
II	Separation of Liquid-Liquid (any Six) and Solid -Liquid (any Five) organic mixture: 1. **Components of the liquid-liquid mixture** should include volatile liquids like acetone, methyl acetate, ethyl acetate, isopropyl alcohol, ethyl alcohol, EMK and non volatile liquids like chlorobenzene, bromobenzene, aniline, N, N dimethylaniline, acetophenone, nitrobenzene, ethyl benzoate. 2. **Components of the liquid - solid mixture** should include volatile liquids like acetone, methyl acetate, ethyl acetate, ethyl alcohol, IPA, EMK and solids such as water insoluble acids, phenols, bases, neutral. 3. A sample of the mixture 1ml to be given to the student for detection of the physical type of the mixture. 4. After correct determination of physical type, separation of the binary mixture to be carried out by using microscale technique. 5. After separation into component A and component B, the compound to be identified can be decided by examiner. 6. After the correct determination of chemical type, the separating reagent should be decided by the student for separation. 7. Follow the separation scheme with the bulk sample of the binary mixture.

	8. After separation into component A and component B, one component (decided by the examiner) is to be analyzed and identified with m.p

REFERENCES:

1. Vogel Textbook of Quantitative Chemical Analysis G.H. Jeffery, J. Basset.

2. Advanced experiments in Inorganic Chemistry., G. N. Mukherjee., 1st Edn., 2010.U.N.Dhur & Sons Pvt Ltd .

3. Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, CBS Publishers and Distributors.

4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).

5. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).

Course Code 25BUCH6TE1	Course Title: Advances in Analytical Chemistry-II	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Understand the principles, instrumentation, and theory of polarography, quantitative, qualitative, methods, applications with advantages and limitations.	L2
CO2	Understand the principles, instrumentation, detectors, and applications of gas chromatography, and differentiate between GSC and GLC.	L2
CO3	Understand the chemistry of food processing and preservation and the composition and functions of common cosmetic products.	L2
CO4	Understand the principles, instrumentation, and applications of thermal analysis techniques (TGA and DTA) and the fundamentals of analytical method validation.	L3

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	2
CO2	3	1	0	0	0	2
CO3	3	1	0	1	0	2
CO4	3	2	1	0	0	2

UNIT I	UNIT I: Electro Analytical Techniques And Methods of Separation 1.1 Polarography (Numerical and word problems are expected) 1.1.1 Difference between potentiometry and voltammetry, Polarizable and non-polarizable electrodes 1.1.2 Basic principle of polarography, H shaped polarographic cell, DME . 1.1.3 DC polarogram: Terms involved - Residual current, Diffusion current, Limiting current, Half-Wave Potential Role and selection of supporting electrolyte, Interference of oxygen and its removal, Qualitative and Quantitative aspects of polarography: Half wave potential $E_{1/2}$, Factors affecting E1/2,: Ilkovic equations: various terms involved in it (No derivation) 1.1.4 Quantification : Wave height – Concentration plots (working plots/calibration), Internal standard method, Standard addition method. 1.1.5 Applications (e.g. in pharmaceutical industry, amperometric titrations, analysis of Alloy etc.) advantages and limitations 1.2 Gas Chromatography (Numerical and word problems are expected) 1.2.1 Introduction, Principle, Instrumentation (Detectors: TCD, FID, ECD) and applications of gas Chromatography. 1.2.2 Comparison between GSC and GLC	**15**
UNIT II	**2.1 Introduction to food and Cosmetics, chemistry** 2.1.1 Food processing and preservation: Introduction, need, chemical methods, action of chemicals (sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar), Physical methods (Pasteurization and Irradiation), decoration of food using edible chemicals.	**15**

	2.2 Cosmetics 2.2.1 Introduction to cosmetics 2.2.2 Study of various cosmetic products (Face powder, Lipsticks, deodorant, antiperspirant) 2.3 Thermal Methods of analysis 2.3.1 Introduction to various thermal methods (TGA, DTA and Thermometric titration) 2.3.2 Thermogravimetric Analysis (TGA) Instrumentation-block diagram, thermobalance (Basic components: balance, furnace, temperature measurement and control, recorder) Thermogram (TG curve) for $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$, Factors affecting thermogram-Instrumental factors and Sample characteristics. 2.3.3 Differential Thermal Analysis (DTA): Principle, Instrumentation, and Reference material used Differential thermogram (DTA curve) $CuSO_4.5H_2O$, Applications; Qualitative and Quantitative analysis, Polymer analysis, Phase transitions 2.4 Analytical Method Validation Validation Parameters: Introduction and Need for Validation of method, Selectivity, Linearity, Precision, Accuracy**,** Sensitivity, Range, Limit of Detection, Limit of Quantification.	

Reference Books:

1. Analysis of food and Beverages, George Charalanbous, Academic press 1978
2. An Advance Dairy chemistry, V 3, P. F. Fox, P. L. H. McSweeney Springer
3. Analytical Chemistry of Open Learning(ACOL),James W. Dodd& Kenneth H. Tonge
4. Chemical methods of separation, J A Dean, Van Nostrand Reinhold, 1969
5. Food Analysis, Edited by S. Suzanne Nielsen, Springer
6. Formulation and Function of cosmetics, Sa Jellineck
7. Government of India publications of food drug cosmetic act and rules.
8. High Performance Thin Layer Chromatography in Food analysis, by Prem kumar, CBS Publisher and distributer
9. Modern cosmetics, E. Thomessen Wiley Inter science
10. Principles of Instrumental Analysis, 5th Edition, By Skoog, Holler, Nieman
11. Principles of Polarography by Jaroslav Heyrovský , Jaroslav Kůta, 1st Edition, Academic Press, eBook ISBN: 978148326478

Course Code 25BUCH6PE1	Course Title: Practicals Based on 25BUCH6TE1	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	*Determine* the concentration of biomolecules such as glycine and reducing sugars in samples using classical and chemical methods.	L3
CO2	*Estimate* metal ions like Mg^{2+}, Zn^{2+}, and Cr^{3+} in samples using ion-exchange resins and spectrophotometric techniques.	L4
CO3	*Perform* potentiometric and pH-metric estimations of acids, such as acetic acid in vinegar and phosphoric acid in cola, and *interpret* the results accurately.	L4
CO4	*Determine* the concentration of Chromium in a water sample using spectrophotometry with diphenyl carbazide and *analyze* the accuracy of the results.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	0	0	0	2
CO2	3	3	1	0	0	3
CO3	3	3	1	0	0	3
CO4	3	3	1	3	0	3

	Non-Instrumental
1	To find the amount of Glycine in the given solution by the titrimetric method.
2	Estimation of reducing sugar in honey by Willstatter method.
3	Estimation of Mg^{+2} & Zn^{+2} ions by using an anion exchange resin.
4	To determine concentration and complexion of Ni^{2+} Ion with EDTA conductometrically
5	To determine stability constant Fe(III) salicylic acid complex
6	To estimate the amount of calcium present in the whole of the given solution being provided with oxalic acid crystals and approximately 0.05 N solution of potassium permanganate as the link (Estimation of calcium – Direct method).
7	To estimate the amount of calcium present in the whole of the given solution being provided with pure crystals of oxalic acid and approximately 0.05 N solution of potassium permanganate as the link (Estimation of calcium – Indirect method).
	Instrumental
8	To determine concentration of Mn^{2+} ions in the given solution by periodate method
9	Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically.
10	Determination of phosphoric acid in cola sample pH metrically.
11	Estimation of Chromium in water sample spectrophotometrically by using Diphenyl carbazide.
12	To determine the equivalent conductance of a given electrolyte solution and to study the effect of dilution on equivalent conductance
13	To determine the amount of copper in the given solution by titrating it against EDTA solution spectrophotometrically.

14	To determine the effect of pH on λmax
15	To determine the concentration of a given dye (methyl orange)

References:

1. Vogel's Textbook of Quantitative Chemical Analysis, 5thEdn., G. H. Jeffery, J Bassett, J Memdham and R C Denney, ELBS with Longmann (1989).
2. Vogel's Textbook of Quantitative Chemical analysis, Sixth edition, J. Mendham et.al
3. The chemical analysis of food and food products III edition Morris Jacob.
4. The chemical analysis of food by David Pearson and Henry Edward.
5. Instrumental Methods of Analysis by Anand & Chatwal.
6. Spectrophotometric Identification of Organic Compounds by Silverstein.
7. Practical Pharmaceutical Chemistry by A. H. Beckett and J. B. Stenlake.
8. Analytical chemistry by H Kaur

Course Code 25BUCH6TE2	Course Title: Chemistry of Soil and Dairy	Credit 2	No. of Lecture 30

Course Outcomes:

CO1	Understand soil properties, classification, and testing for agricultural use.	L2
CO2	Analyze fertilizers and agrochemicals in crop production.	L4
CO3	Understand milk composition and dairy processing methods.	L2
CO4	Evaluate milk nutrients and milk product processing and safety.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	2	0	2
CO2	3	3	0	3	0	3
CO3	3	1	0	0	0	2
CO4	3	3	0	2	0	3

UNIT I	**1.1 Soil Chemistry:** 1.1.1 Introduction to soil chemistry, definitions of soil, Soil components, soil atmosphere, soil water, soil microorganisms. 1.1.2 Physical and chemical properties of soil, Surface soil and sub-soil, Functions of soil. 1.2. Types of Soil and Soil testing: 1.2.1 Introduction to Problematic Soils. 1.2.2 Classification of alkali soil- Acid soil, saline soil, alkali soil, saline alkali soil, non-saline alkali soil. 1.3 Fertilizers and Manures: 1.3.1 Introduction, Classification of nitrogenous fertilizers, reaction of ammonium sulphate, urea as a fertilizer in soil. 1.3.2 Introduction to - Nano fertilizers, Phosphatic fertilizers, Potassic fertilizers. 1.3.3 Complex fertilizers, Mixed fertilizers - Characteristics, advantages and disadvantages, 1.4 Protection of plant: 1.4.1 Pesticides- Definition, Classification. 1.4.2 Insecticide- Definition, Classification based on mode of action and chemical properties, (Organic, Organochlorine, and Organophosphorus	**15**
UNIT II	**2.1 Market Milk**: 2.1.1 Introduction, Definition, and constituents of milk. Factor affecting composition of milk. 2.1.2 Special Milks (Sterilized milk, Homogenized milk, Soft curd milk, Flavored milk, Vitaminised / irradiated milk, Fermented milk, Standardized milk)- Definition, characteristics, method of manufacture in detail, advantages and disadvantages. 2.1.3 Physicochemical properties of milk, acidity, pH, density, specific gravity, color and flavor of milk, food and nutritive value of milk. **2.2. Common Dairy Processes:**	**15**

	2.2.1 Cream separation- Basic principles, gravity creaming water dilution and centrifugal creaming method. 2.2.2 Pasteurization of milk, flow sheet diagram. 2.2.3 Process receiving milk, Preheating filtration, clarification, cooling and storage raw milk, standardization, homogenization, **2.3 Milk proteins, Carbohydrates and Vitamins:** 2.3.1 Milk proteins (casein, albumin, and globulin)- composition, nomenclature, properties and uses. 2.3.2 Carbohydrates (Lactose)- importance, nutritive value, uses. 2.3.3. Vitamins (, Vit-A, Vit-B, B2, B6, B12, Vit-C (Ascorbic acid) & Vitamin-D)- importance, definition, properties, nutritive value. **2.4 Milk Products and milk Adulteration** 2.4.1 Cream, Butter, Cheese and Ice-Cream- Cream- Definition, Classification, Composition, Food & Nutritive value, Physicochemical properties, Manufacture and uses. 2.4.2 Dried Milk Products- Introduction, butter milk powder, whey powder, cream powder, infact milk powder, Shrikand powder, Ice-cream mix powder, cheese powder.	

Reference Books:

1. A text book of soil science (Revise Edition) J. A. Daji. Revised by J. R. Kadam, N. D. Patil, Media promoters and publishers, Mumbai, 1996.
2. Principals of soil science, M. M. Rai, 4th ed. Million complex of India, Bombay, 1977.
3. Manures and fertilizers (12th ed.), K. S. Yawalkar, J. P. Agarwal and Bokde, Agrihorticulture publishing house, Nagpur, 2016.
4. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd ed.), oxford and IBH Publishing company, New Delhi.
5. Fundamentals of soil sciences, Henry D. Foth, 8th ed. John Wiley and Sons, 1990.
6. Soil, Plant, Water and fertilizer analysis, P. K. Gupta, 2nd ed. Agrobios Publication, Jodhpur, India.
7. Essential Plant Nutrients uptake use efficiency and Management, M. Naeem, Abid A. Ansari, Sarvajeet Singh Gill Editor, Springer International Publishing AG, 2017.
8. Laboratory Guide for Conducting Soil Tests and Plant Analysis, J. Benton Jones Jr. CRC Press, 2001.

Course Code 25BUCH6PE2	Course Title: Practicals Based on 25BUCH6TE2	Credit 2	No. of Lecture 60

Course Outcomes:

CO1	Apply analytical chemistry techniques for the qualitative and quantitative estimation of essential elements, nutrients, and contaminants in agricultural, environmental, and industrial samples.	L3
CO2	Demonstrate the ability to detect, isolate, and evaluate key components and adulterants in food and dairy products using standard chemical analysis methods.	L4
CO3	Perform biochemical analyses to isolate and quantify key nutritional components such as lactose, fats, and oils from food and dairy products	L3
CO4	Identify and evaluate common food adulterants and contaminants in dairy and food products using chemical detection methods.	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	0	3
CO2	3	3	0	1	1	3
CO3	3	2	0	0	0	3
CO4	3	3	0	2	0	3

	Fertilizers and Pesticides: (Perform any 5)
1	Estimation of nitrogen form ammonium sulphate.
2	Estimation of Ca form super phosphate.
3	Determination of salinity of soil by conductometrically.
4	Estimation of phosphorus from soil by cloroimetrically.
5	Analysis of mixed fertilizers and micronutrients.
6	Analysis of organic manures. i) Moisture content ii) Organic matter and ash content.
7	Determination of Alkalinity of water.
8	Ion exchange chromatographic separation and determination of Zn(II) and Mg(II).
9	Separation and detection of pesticide by thin layer chromatography.
10	Determination of dissolved Chlorine gas in a given water sample by iodometric titrations.
11	Saponification and acid values of oil.
	Dairy Chemistry: (Perform any 3)
12	Isolation of Lactose from milk.
13	Determination of Acid value in Fats and oils , Iodine value in Fats and oils
14	Detection of Urea in Milk, Starch in Milk, Nitrate in Milk, preservatives in milk a) formaldehyde b) boric acid, of pH of Buffalo and Cow milk.
15	Detection of adulterants in ice cream, red chili powder, sugar /dextrose from Honey

Course Code 25BUCH6VSC	Course Title: Pharmaceutical Chemistry	Credit 2	No. of Lecture 45

Course Outcomes:

CO1	Explain drug classification, nomenclature, pharmacological concepts, and the principles of drug administration, dosage forms, and metabolism.	L2
CO2	Classify, describe, and explain the synthesis, mechanisms of action, and therapeutic uses of major drug classes, including CNS, analgesic, antipyretic, anti-inflammatory, antihistaminic, cardiovascular, antidiabetic, antiparkinsonian, and respiratory agents.	L4

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	0	0	0	3
CO2	3	2	0	0	0	3

UNIT I	1.1 General Introduction to Drug 1.1.1 Definition of a drug, Requirements of an ideal drug, Classification of drugs (Based on therapeutic action) 1.1.2 Nomenclature of drugs: Generic name, Brand name, Systematic name 1.1.3 Definition of the following medicinal terms: Pharmacon, Pharmacophore, Prodrug, Half Life efficiency, LD50, ED50, Therapeutic Index. 1.1.4 Brief idea of the following terms: Receptors, Drug receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia 1.2 Routes of Drug Administration and Dosage Forms 1.2.1 Oral and Parenteral routes with advantages and disadvantages 1.2.2 Formulations, Different dosage forms (emphasis on sustained release formulations.) 1.3 Drug Metabolism Introduction, Absorption, Distribution, Bio transformation, Excretion Different types of chemical transformation of drugs with specific examples..	**15**

Reference Books:

1. Synthetic Drugs, G.R. Chatwal, Himalaya Publishing House, 2nd Edition
2. Synthetic Drugs, M. S. Yadav, Campus Books International, 2nd Edition

Course Code 25BUCH6VSC	VSC: Practical Course Title: Practicals Based on Pharmaceutical Chemistry	Credit 2	No. of Lecture 45

Course Outcomes:

CO3	Apply analytical techniques and standard laboratory procedures to estimate drug concentrations and synthesize pharmaceutical formulations and reagents for practical pharmaceutical analysis.	L3
CO4	Synthesize and formulate pharmaceutical compounds by applying standard procedures and reactions such as O-methylation, acetylation, and nitration, and prepare drug monographs in accordance with IP methods	L5

Grading will be as 3: High (>60%), 2: Moderate (40%-60%), 1: Low (<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO3	3	2	1	0	**1**	3
CO4	3	3	1	0	1	3

	[I] Estimation:
1	Estimation of Ibuprofen (back titration method)
2	Estimation of Acid neutralizing capacity of a drug
3	Estimation of Tincture Iodine.
4	Estimation of free acid in vegetable oil.
	[II] Preparation:
5	Preparation of Paracetamol from p-aminophenol.
6	Preparation of Aspirin from salicylic acid.
7	Preparation of p-nitroaniline from p-nitroacetanilide
8	Preparation of a monogram of any one drug from the syllabus by the IP method.
9	Industrial Visit

References:

1. Skoog D.A., West D.M., Holler F.J., Stanley R.C., Fundamentals of analytical Chemistry, 9 th Edition, Cengage Learning.
2. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis, 6th Edition, Prentice Hall. 3. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical Chemistry, 8 th Edition, McGraw-Hill, New York.
4. Vogel's Textbook of Practical Organic Chemistry 6. Vogel - A Text-Book of Quantitative Inorganic Analysis

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

Curriculum Structure for the Undergraduate Degree Programme T.Y.B.Sc. Chemistry

	SEMESTER – V	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUCH5T01	Advances in Physical Chemistry-I	√	--	--	--	--	--	--
25BUCH5T02	Advances in Inorganic Chemistry-I	√	--	--	--	--	--	--
25BUCH5T03	Advances in Organic Chemistry-I	√	--	--	--	--	--	--
25BUCH5P01	Practicals Based on **25BUCH5T01**	√	√	√	--	--	--	√
25BUCH5P02	Practicals Based on **25BUCH5T02**	√	√	√	--	--	--	√
25BUCH5P03	Practicals Based on **25BUCH5T03**	√	√	√	-	--	--	√
DSE								
25BUCH5TE1	Advances in Analytical Chemistry-I	√	√		-	-	-	
25BUCH5PE1	Practicals Based on **25BUCH5TE1**	√	√	√	-	-	-	
OR								
25BUCH5TE2	Industrial Chemistry	√	√		-	-	-	
25BUCH5PE2	Practicals Based on **25BUCH5T05**	√		√	-	-	-	
Minor								
25BUCH5TMN	Dyes Chemistry	√	√	√	--	--	--	--
VSC								
25BUCH5VSC	Chemtech: Vocational excellence in chemical Applications	√	√	√	--	--	√	--
25BUCH5OJT / 25BUCH5FPR	On Job Training in Chemistry-I/ Field Project in Chemistry-III	√	√	√	--	--	√	√
	Total	**13**	**09**	**08**	**00**	**00**	**02**	**04**

	SEMESTER – VI	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
25BUCH6T01	Advances in Physical Chemistry-II	√	--	--	--	--	--	--
25BUCH6T02	Advances in Inorganic Chemistry-II	√	--	--	--	--	--	--
25BUCH6T03	Advances in Organic Chemistry-II	√	--	--	--	--	--	--
25BUCH6IKS	Indian Knowledge System	√	--	√	--	--	--	--
25BUCH6P01	Practicals Based on 25BUCH6T01	√	√	√	--	--	--	√
25BUCH6P02	Practicals Based on 25BUCH6T02	√	√	√	--	--	--	√
25BUCH6P03	Practicals Based on 25BUCH6T03	√	√	√	--	--	--	√
DSE								
25BUCH6TE1	Advances in Analytical Chemistry- II	√	√	√	-	-	√	
25BUCH6PE1	Practicals Based on 25BUCH6TE1	√	√	√	--	-	√	√
OR								
25BUCH6TE2	Chemistry of soil and dairy.	√	√	√	-		√	√
25BUCH6PE2	Practicals Based on 25BUCH6TE2	√	√	√	-	-	√	√
VSE								
25BUCH6VSC	**Pharmaceutical Chemistry**	√	√	√	-	-	√	√
25BUCH6OJT / 25BUCH6FPR	On Job Training in Chemistry-II/ Field Project in Chemistry-IV	√	√	√	-	-	√	-
	Total	**09**	**09**	**14**	**07**	**02**	**02**	**02**

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