Curriculum Framework Syllabus
B.Sc. (Chemistry) 2023-24
L-7 (VI Semester)

Level / Semester	Nature of Course	Courses Code	Course Title	MM	L	T	P	C
L-7	Discipline Specific: Major	CHE-DSM-611	Organometallics, Polynuclear Aromatics, Heterocycles, and Organic spectroscopy (Theory)	100	4	0	0	4
	Discipline Specific: Major	CHE-DSM-612	Chemistry Laboratory (Practical)	100	0	0	2	2
VI Semester	Discipline Specific: Major	DSM-613	Other Department	100	6	0	0	6
	Multi Discipline Major	CHE-MDM-611	Instrumental Methods of Chemical Analysis (Theory)	100	4	0	0	4
	Multi Discipline Major	CHE-MDM-612	Instrumental Methods of Chemical Analysis (Practical)	100	0	0	2	2
	Skill Enhancement Course (SEC)	CHE-SEC-611	Pharmaceutical Chemistry (Theory)	100	2	0	0	2
	Value Enhancement Course	VEC-611	Other Department					Qualifying
Total Credits								**20**

Bachelor of Science – B.Sc.
Discipline Specific Major (DSM)
B.Sc. VI Semester
CHE-DSM-611: Organometallics, Polynuclear Aromatics, Heterocycles, and Organic spectroscopy (Theory)

Credit: 04	Time: 60 Hrs

Course Learning Objectives: To impart basic and advance knowledge of Inorganic Complex organometallic compounds, bioinorganic chemistry, heterocyclic compounds, polynuclear hydrocarbons and applications of spectroscopy.

Course Learning Outcomes: Upon successful learning, students will be able to

Unit I: Understand the chemistry of 3d metals, metal complexes and bioinorganic chemistry.

Unit II: Understand about the chemistry of organometallic compounds including their preparation, structure, bonding and properties.

Unit III: Learn the chemistry of heterocyclic compounds including their preparation, properties and reactivities.

Unit IV: Understand and explore the chemistry of polynuclear aromatic hydrocarbons and active methylene compounds.

Unit V: Learn about the applications of spectroscopy to characterize organic molecules.

Unit I	**Chemistry of 3d metals:** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$. **Bio-Inorganic Chemistry**: A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	12
Unit II	**Organometallic Compounds**: Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behavior of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).	12
Unit III	**Polynuclear Aromatic Compounds and Active methylene compounds:** Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Phenanthrene. Active methylene compounds: Preparation: Claisen ester condensation. Keto-enol tautomerism. Reactions: Synthetic uses of ethyl acetoacetate (preparation of non-heteromolecular having upto 6 carbon).	12
Unit IV	**Heterocyclic Compounds:** Introduction and definition: Simple five membered ring compounds with one hetero atom, Examples: Furan. Thiophene and pyrrole - Aromatic character, Preparation from 1,4,- dicarbonyl compounds, Paul-Knorr synthesis. Properties: Acidic character of pyrrole - electrophillic substitution at 2 or 5 position, Halogenation, Nitration and Sulphonation under mild conditions - Diels Alder reaction in furan. Pyridine – Structure - Basicity - Aromaticity - Comparison with pyrrole, one method of preparation and properties - Reactivity towards Nucleophilic substitution	12

	reaction.	
Unit V	**Application of Spectroscopy to Simple Organic Molecules:** Application of visible, ultraviolet, and Infrared spectroscopy in organic molecules. Electromagnetic radiations, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating l max of conjugated dienes and α,β – unsaturated compounds. Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes, and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions). Basics of NMR Spectroscopy.	12

Reference books:

1. James E. Huheey, Ellen Keiter & Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication
2. B. R. Puri, L.R. Sharma, K.C. Kalia, Principle of Inorganic Chemistry, 33rd edition, Vishal Publishing Co.
3. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, John-Wiley & Sons.
4. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
5. D. F. Shriver and P. W. Atkins: *Inorganic Chemistry*, Oxford University Press. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.
6. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
7. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
8. I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
9. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
10. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman
11. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
12. W. Kemp, Organic Spectroscopy, Third Edition, ELBS.
13. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.

Bachelor of Science – B.Sc.
Discipline Specific Major (DSM)
B.Sc. VI Semester
CHE-DSM-612: Chemistry Laboratory (Practical)

Credit: 02	Time: 30 Hrs

Course Learning Objectives: To impart practical knowledge including procedure and experimental Inorganic and Organic Chemistry.

Course Learning Outcomes: Upon successful learning, students will be able to

- Learn to synthesize various inorganic complexes and understand their properties.
- Understand to synthesize tetraamine copper and tetraamine carbonatocobalt complex compounds.
- Learn to prepare Potassium tris(oxalate)ferrate (III) trihydrate and acetylacetonate complexes of Cu^{2+}/Fe^{3+}.
- Understand and learn the method of separation and systemic identification of binary organic mixtures.
- Understand and learn UV, IR and NMR spectroscopy to characterize simple organic compounds.

Laboratory course

Inorganic Chemistry Laboratory

Preparation of following complexes

(1) Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
(2) *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III)
(3) Tetraamminecarbonatocobalt (III) ion
(4) Potassium tris(oxalate)ferrate(III) trihydrate
(5) Preparation of acetylacetonate complexes of Cu^{2+}/Fe^{3+}.

Organic Chemistry Laboratory

Separation and systemic identification of binary Organic mixtures (Mixtures of two solid compounds), and preparation of derivatives.

- Separation with water
- Separation with Sodium bicarbonate
- Separation with Sodium hydroxide

Demonstration of UV, IR and NMR spectroscopy to simple organic compounds.

Reference Books:

1. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
3. Marr & Rockett Inorganic Preparations
4. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Course In Practical Chemistry, New Central Book Agency Pv. Ltd.
5. A.I. Vogel: Textbook of Practical Organic Chemistry, Prentice Hall, 5thEdn.
6. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

7. A.I. Vogel, Text Books of Qualitative Organic Analysis, Pearson India; 2nd edition (1 January 2010)
8. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
9. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. VI Semester
CHE-MDM-611: Instrumental Methods of Chemical Analysis (Theory)

Credit: 04	Time: 60 Hrs

Course Objectives:
To impart the basic understanding of Instrumental Methods of Chemical Analysis, and applications among the students.

Course learning outcomes: Upon successful learning, students will be able to
Unit I- Learn about basic of spectroscopic and analytical methods of analysis of chemicals and understand analysis by Infrared spectroscopy.
Unit II: Learn about basic of UV-Vis spectroscopy, and learn analysis of chemicals by UV-Vis spectroscopy.
Unit III: Understand fundamental knowledge on Mass spectroscopy and learn analysis of chemicals by Mass spectroscopy.
Unit IV: Understand about basics of NMR spectroscopy and learn applications NMR spectroscopy for the determination of the structure of organic compounds
Unit V: Learn about various Chromatography: Gas chromatography, liquid chromatography and their applications for chemical analysis

Unit I	Recap of the spectroscopic methods: Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiation. Infrared spectroscopy: Interactions with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier Transform (FTIR). Samples and results expected. Applications: Issues of quality assurance and quality control, Special problems for portable instrumentation and rapid detection.	12
Unit II	UV-Visible spectroscopy – Electromagnetic radiations, absorption of electromagnetic radiations, chromophore, auxochrome, bathochromic and hypsochromic shifts. electronic transitions, theory of electronic spectroscopy, Beer's-Lambert laws, λmax & εmax, Woodward-Fieser rules, Instrumentation and sampling, solvent effects, interpretation of spectrum, quantitative electronic spectroscopy, determination of unknown concentration, applications of UV-Visible spectroscopy.	12
Unit III	Mass spectroscopy: Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, Detection and interpretation (how this is linked to excitation	18
Unit IV	NMR spectroscopy: Principle, Instrumentation, Factors affecting chemical shift, Spin coupling, Applications NMR spectroscopy for the determine the structure of organic compounds. X-ray analysis and electron spectroscopy (surface analysis).	6
Unit V	Chromatography: Gas chromatography, liquid chromatography, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to	12

	MS), Electrophoresis.	

Reference Books:

1. Principles of Instrumental Analysis - 6th Edition by Douglas A. Skoog, F. James Holler, and Stanley Crouch (ISBN 0-495-01201-7).
2. Instrumental Methods of Analysis, 7th ed, Willard, Merritt, Dean, Settle.
3. C.N. Banwell: Fundamentals of Molecular Spectroscopy.
4. Brian Smith: Infrared Spectral Interpretations: A Systematic Approach. • W.J. Moore: Physical Chemistry.
5. W. Kemp, Organic Spectroscopy, Third Edition, ELBS.
6. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.

Bachelor of Science – B.Sc.
Multidisciplinary Major (MDM)
B.Sc. VI Semester
CHE-MDM-612: Instrumental Methods of Chemical Analysis (Practical)

Credit: 02	Time: 30 Hrs

Course Learning Objectives: To provide basic concept of experimental methodologies on Instrumental Methods of Chemical Analysis

Course Learning Outcomes: Upon successful learning, students will be able to

Unit I- Learn about safety protocol in chemistry laboratory.

Unit II: Learn the determinations of isoelectric point.

Unit III: Understand determination of a Mixture of Cobalt and Nickel (UV/Vis spec.),

Unit IV: Understand about quantitative Analysis of Mixtures by Gas Chromatography and NMR. and learn applications NMR spectroscopy for the determination of the structure of organic compounds.

Unit V: Learn about separation and identification by Chromatography: Gas chromatography, liquid chromatography.

Laboratory course

1. Safety Practices in the Chemistry Laboratory
2. Determination of the isoelectric pH of a protein.
3. Titration curve of an amino acid.
4. Determination of a Mixture of Cobalt and Nickel (UV/Vis spec.)
5. Study of Electronic Transitions in Organic Molecules (i.e., acetone in water)
6. Absorption Spectra (Study of Aldehydes and Ketones)
7. Analysis of Mixtures by Gas Chromatography and NMR
8. Determination of the structure of organic compounds by NMR
9. Separation of Carbohydrates by HPLC
10. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink
11. Spectrophotometric determination of Iron in Vitamin / Dietary Tablet.

Reference Books:

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog & Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
8. Vogel, A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Prentice Hall.

9. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

10. Douglas A. Skoog, F. James Holler, and Stanley Crouch, Principles of Instrumental Analysis - 6th Edition (ISBN 0-495-01201-7).

11. Willard, Merritt, Dean, Settle Instrumental Methods of Analysis, 7th ed,

Bachelor of Science – B.Sc.
Skill Enhancement Course (SEC)
B.Sc. VI Semester
CHE-SEC-611: Pharmaceutical Chemistry (Theory)

Credit: 02	Time: 30 Hrs

Course Objectives:
To impart the basic understanding of pharmaceutical chemistry and its significance among the students.

Course learning outcomes: Upon successful learning, students will be able to
Unit I- Learn the basic concept of pharmaceutical chemistry, drug design and development.
Unit II: Understand and learn the design and synthesis of analgesics agents, antipyretic agents, and anti-inflammatory agents.
Unit III: Learn about Antiviral agents, Central Nervous System agents, Cardiovascular drugs, their synthesis, and specific medicinal uses.
Unit IV: Understand and learn about Antibiotics and antifungal agents, their synthesis, and specific medicinal uses.
Unit V: Learn about vitamins and their uses and roles, fermentation processes for production of ethanol and citric acid.

Unit I	Definition of drugs, Classification, Drug targets, Drug design and development; drug discovery and lead compounds. Basic Retrosynthetic approach for design and synthesis of drug molecules.	06
Unit II	Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, lobuprofen).	06
Unit III	Antiviral agents (Acyclovir), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT-Zidovudine). Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular drugs (Glyceryl trinitrate),	06
Unit IV	Antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin.	06
Unit V	Vitamins and fermentation: Aerobic and anaerobic fermentation. Production of Ethyl alcohol and citric acid. Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	06

Reference Books:

1. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK.
2. William O. Foye, Thomas L., Lemke, David A. William: Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd. New Delhi.
3. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.
4. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.
5. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.