VANITA VISHRAM WOMEN'S UNIVERSITY
SCHOOL SCIENCE AND TECHNOLOGY
DEPARTMENT OF CHEMISTRY

MASTER OF SCIENCE (M.Sc.) CHEMISTRY
under Learning Outcomes-based Curriculum Framework (LOCF)
for Post Graduate (PG) Education

SEMESTER 3
Core Courses (CC), Ability Enhancement Compulsory Courses (AECC), Generic Elective Courses (GE)

Syllabus applicable to the students seeking admission in the following programmes
M.Sc Chemistry under LOCF w.e.f. the Academic Year 2021-2022

1. Preamble – VVWU

Vanita Vishram Women's University (VVWU) is the First-ever Women's University of Gujarat approved by the Government of Gujarat under the provisions of the Gujarat Private Universities Act, 2009. It is a university committed to achieve Women's Empowerment through Quality Education, Skill Development, and by providing employment opportunities to its girl students through its model curriculum, integration of technology in pedagogy and best-in-class infrastructure. The focus is on prioritizing practical component and experiential learning supported through academia-industry linkages, functional MoUs, skill development training, internships etc. It aims at providing opportunities to the girl students for holistic development and self-reliance.

VISION

Empowerment of women through quality education and skill development, so as to make them strong pillars of stability in the society.

MISSION

To provide Education & Professional Training to all women for their all-round development, so as to enable them to become economically independent and socially empowered citizens.

2. Introduction of the Programme

Higher study in chemistry is a current need of the competitive environment. The M.Sc. organic chemistry and chemistry programmes provides knowledge and skill-based training to the students to flourish in research and in the professional career. The course offers a deep understanding of concept, theory and experiments that make students reach knowledge of chemistry. The dissertation in the end semester provides a research environment for the student to build a career in the research field.

3. Programme Specific Objectives (PSOs)

- To motivate critical thinking and analysis skills to solve complex problems to improve human life.
- To impart the basic analytical and technical skills to work effectively in the various fields of chemistry.
- To demonstrate an ability to conduct experiments with mastery of appropriate techniques and proficiency using core chemical instrumentation.
- To provide professional services to industry, Research organization, institutes.
- To provide value based and ethical leadership in the professional and social life.

4. Programme Specific Outcomes (PSOs)

- In-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods of chemistry.
- Apply/implement interface between, on the one hand, the history of chemistry and natural science and, on the other hand, issues pertaining to the areas of modern technology, health, and environment.
- Skills in planning and conducting advanced chemical experiments and applying structural-chemical characterization techniques.
- Skill in examining specific phenomena theoretically and/or experimentally
- Generation of new scientific insights or to the innovation of new applications of chemical research.

Master of Science (M.Sc.) Chemistry

Semester-3

Core Course

CH21170

Advanced Inorganic chemistry (Credit 4+1)

Course objective:

- To understand the complex formation
- To understand Complex formation of Nitrosyl complex
- The detailed knowledge of complex and industrial application
- To study application of Coordination chemistry in different fields.

Prerequisites:

- Lerner should have
- Basic understanding of periodic elements
- Brief understanding Organometallic compounds

Unit-1 Metallic Nitrosyls complexes

Introduction, Metallic Nitrosyls containing NO+ ions, Metallic Nitrosyls containing NO- ions, Metallic Nitrosyls containing NO^{+}as well as NO^{-} ions, to calculate EAN of the central metallic atom in metallic nitrosyls, Nitroso ferrous sulphate, sodium pentacyanonitrosyl ferrate, sodium nitroprusside.

Unit-2 Chemical and biofertilizers

Definition, classification, methods of production, chemical properties and uses of urea, ammonium sulphate, ammonium sulphate nitrate, ammonium chloride, single super phosphate, triple super phosphate, biofertilizers, types of biofertilizers, nitrogen fixing biofertilizers, phosphate–solubilizing biofertilizers, preparation of a biofertilizers.

Unit-3 Industrial Application of Organometallic compounds

Importance of Organometallic compounds as catalyst (Hydrogenation of Olefins, Importance of Wilkinson's catalyst), Preparation of catalyst [RhCl(PPH3)], role of rhodium metal in the catalytic process, Mechanism of Hydrogenation of Olefins using Wilkinson catalyst, the Oxo process, Fishers tropsch synthesis, Asymmetric synthesis

Unit -4 Kinetics and Mechanisms of Reactions of Coordination Compounds

Labile and Inert complexes, VBT explanation of lability and inertness, Traube's explanation of Lability and inertness, Ligand substitution reactions, SN1, SN2, SN1CB, Anation reaction, redox, OSM, ISM, OSM versus ISM, reaction of coordinated ligands.

Isomerism reaction involving Geometrical and optical isomers., electron transfer in biological systems.

Reference Books

- Inorganic Chemistry, J.E. Huheey, K.A. Keiter and R.L. Keiter, Harper Cottens College Publications, 1993.
- Concise Inorganic Chemistry by J.D. Lee, Chapman & Hall, 1996.
- Principles of inorganic chemistry by B.R. Puri, L.R. Sharma & K.C. Kalia, Milestone Publishers, 2017.
- Introduction to Coordination Chemistry by G. A. Lawrance, John Wiley & Sons, 2013.
- Textbook of Coordination Chemistry by R. K. Sharma, Discovery Publishing House, 2007.
- Essentials of Coordination Chemistry: A Simplified Approach with 3D Visuals by Vasishta Bhatt, Academic Press, 2015.
- Inorganic Chemistry by J. E. House, Academic Press, 2010.
- Inorganic Chemistry by G. L. Miessler, P. J. Fischer, D. A. Tarr, Pearson, 2014.
- Shriver and Atkins' Inorganic Chemistry by P. Atkins, T. Overton, OUP Oxford, 2010.
- Concise coordination chemistry by M. J. Xavier, R. Gopalan, V. Ramalingam, Sangam Books Limited, 2001.
- Organometallic Chemistry by R. C. Mehrotra, New Age International, 2007.
- Basic Organometallic Chemistry: Concepts, Syntheses and Applications by B. D. Gupta, Universities Press, 2011.
- The Organometallic Chemistry of the Transition Metals, R. H. Crabtree, John Wiley & Sons, 2014.
- Organometallic Chemistry and Catalysis by D. Astruc, Springer Science & Business Media, 2007.
- Quantum Chemistry, N. Levine, Prentice Hall, New York

Core Course

CH21180

Advanced Organic Chemistry (Credit 4+1)

Course objective:

- Understanding the mechanism and stereochemistry aspects of organic reactions of alcohols and carbonyl compounds.
- Interconversion and mechanism of carboxylic acid derivatives and its reactions.
- Useful transformation through oxidizing and reducing agents and its dynamic stereochemistry.
- Sigmatropic reactions and its application in organic chemistry with stereochemistry.

Prerequisite:

- Basic concepts of elimination and substitution reactions.
- General aspects of oxidation and reduction reactions.
- Basic concepts of HOMO and LUMO of organic molecules.
- Basic concepts of pericyclic reactions and its applications.

Unit-I Enolate and functional groups trastermation reactions

Reactions of enolates with carbonyl compounds: the aldol and Claisen reactions, Enols and enolates, Electrophilic addition to alkenes, Nucleophilic substitution reactions, Conjugate additions, new C–C bonds using, carbonyl compounds as nucleophiles, Alcohols to alkylating agents, Mitsunobu and related reactions, nucleophilic cleavage of C-O bonds in ethers and esters and inter-conversion of carboxylic acid derivatives

Unit-II Oxidation

Metal based oxidizing reagents: A review and detailed discussion of chromium, manganese, ruthenium, silver and other metal-based reagents. Non-metal based oxidizing reagents: DMSO, peroxide, peracid and oxygen-based oxidation. Miscellaneous oxidizing reagents like IBX, DMP, CAN, DDQ, periodate etc. alkenes to alcohols/carbonyls without bond cleavage, hydroboration-oxidation, Wacker oxidation, and selenium based allylic oxidation, Asymmetric epoxidation (Sharpless, Jacobsen, and Shi epoxidation) and Sharpless asymmetric dihydroxylation.

Unit-III Reduction

(a) Catalytic homogeneous and heterogeneous hydrogenation, Wilkinson catalyst. (b) Metal based reductions using Li/Na in liquid ammonia, sodium, magnesium, zinc, titanium, and samarium. (c) Hydride transfer reagents: NaBH4, L-selectride, K-selectride, Luche reduction, LiAlH4, DIBAL-H, Red-Al, Trialkylsilanes, and Trialkylstannane. (d)

Enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata) and Noyori asymmetric hydrogenation.

Unit-IV Molecular rearrangements

Illustration of electron deficient and electron rich skeletal rearrangements with examples; Sigmatropic rearrangements-Claisen and related rearrangements, Cope and oxy-Cope rearrangements; 2,3-sigmatropic rearrangements and ene reaction.

Reference Books

- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press Inc., New York (2001).
- McMurry, J.E. Fundamentals of Organic Chemistry, Seventh edition Cengage Learning, 2013.
- P Sykes, A Guidebook to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
- F. A. Carey and R. J. Sundburg, "Advanced Organic Chemistry, Part B", Fifth Ed., Plenum Press, 2007.

Course outcomes:

An understanding of major concepts, theoretical principles and experimental findings in chemistry of carbonyl, alcohol, oxidizing and reducing reagents and pericyclic reactions.

Core Course

CH21190
Advanced Physical Chemistry (Credit 4+1)

Course objective:

- To understand the phase rule and associated systems.
- To understand Chemical Potential, Fugacity and their physical significance.
  The detailed knowledge of dilute solutions and determination of molecular weight by different methods.
  To study application of Nuclear Chemistry in different fields.

Prerequisites:

- Lerner should have: Basic understanding of Phase of systems and solution behavior
- Brief understanding of colligative properties.
- Knowledge of radioisotopes and nuclear reactions.

Unit-I Phase Rule

The statement of phase rule, Gibb's phase rule, Explanation of the term 'Phase', Explanation of the term 'Component', Degrees of Freedom, Derivation of the phase rule, One–component system, Phase diagrams, Regions or areas , Lines or curves, Triple point, Metastable equilibrium, Polymorphism: (1) Enantiotropy, (2) Monotropy, (3) Dynamic allotropy, Experimental determination of transition point, Colour change, Density change, Solubility change, Cooling curve method, One-component system: The water system, The sulphur system, Reduced phase rule, Two-component condensed system, Simple eutectic systems, The silver–lead system, The zinc–cadmium system, Potassium iodide–water system

Unit-II Open System Thermodynamics

Partial molal free energy, (chemical potential), Derivation of Gibb's Duhem Equation, chemical potential in case of a system of ideal gases. Concept of fugacity, Fugacity function, Fugacity at low pressures, Physical significance of fugacity, Graphical method for determination of fugacity, Lewis fugacity rule. Activity and activity coefficient (Only concept). Standard state, Standard state of Solid, Liquid and Gas, Numerical problems.

Unit-III Theory of Dilute Solutions

Colligative properties, Lowering of vapour pressure : Raoult's law, Ideal solutions and deviations from Raoult's law, Determination of molecular mass from vapour pressure lowering, Measurement of lowering of vapour pressure, Barometric method, Manometric method, Ostwald and Walker's dynamic method (*gas saturation method*), Elevation of boiling point, Determination of molecular mass from elevation of boiling point,

Measurement of the elevation of boiling point, Landsberger-walker method, Cottrell's method, Freezing–point depression, Determination of molecular weight from depression of freezing point, Numerical problems based on above all topics.

Unit-IV Applications of Nuclear Chemistry

Application of radioisotopes: as Tracers in medicines, in agriculture, in studying reaction mechanisms in photosynthesis and age determination by Carbon- Dating method. Q-value of nuclear reactions, Chemical and physical atomic weight scale, Mass defect and Binding energy, Packing fraction and its relationship with the stability of the nucleus, Nuclear fission, Atom bomb, Nuclear reactor for power generation and Critical mass, Stellar energy and Hydrogen bomb, Hazards of nuclear radiation.

Numerical problems based on: Q- value, Binding energy, packing fraction, and Energy released during nuclear reactions.

Course outcomes:

After completion the course, the learner shall be able to:

- Explain phase behaviour and phase diagram of one and two component systems.
- Knowledge for Gibbs free energy, Fugacity and Activity concepts.
- Apply knowledge of the theory of dilute solutions.
- Explore wide applications of Nuclear Chemistry.

Reference Books:

- Physical Chemistry, P. W. Atkins, 6th Edition, ELBS.
- Physical Chemistry by Protuon and Marron.
- A Textbook of Physical Chemistry, Vol. 4, K. L. Kapoor, McMillan, 1985
- Advanced Physical Chemistry, Gurdeep Raj, Krishna Prakashan Media
- Principles Of Physical Chemistry, by Madan S Pathania B R Puri,L R Sharma,Vishal Publishing Co
- Essentials of physical chemistry by A. S. Bhal and G. D. Tuli, Pub : S. Chand
- Essentials of Nuclear Chemistry by H. J. Arnikar (Wiley Eastern Ltd., 1981.

Core Course Practical

CH21200

Inorganic and Organic Chemistry Practical-III (Credit-2)

Course objective:

- Draw logical and detailed mechanisms for various fundamental reactions of arenes.
- Be able to apply concepts associated with these general reaction types to product prediction, synthesis design, and reaction mechanism.
- Classify organic molecules by their functional groups, and identify fundamental properties associated with those functional groups.
- Isolation methods of selected natural products and chemistry extraction process.

Prerequisite:

- Fundamentals of organic reactions such as SN2, SN1, E2, E1, alkene addition, electrophilic aromatic substitution, 1,2/1,4-additions, ring-opening, and radical halogenation.
- Identification of organic compounds through chemical reaction.
- Importance of natural products in chemistry.
- Twelve principles of green chemistry

Inorganic Chemistry Practical -III

Analysis of Brass alloy, Analysis of Hydrogen peroxide (H_2O_2), Analysis of Dolomite Ore ,Analysis of fertilizer sample, Analysis of Stainless Steel, Analysis of German Silver, Analysis of Portland Cement, Analysis of Available lime, Analysis of PO_4^{-3} for K_2HPO_4 spectrometrically, Determine the λmax for Cu-en complex[(1:1), (1:2),(1:3)] complex, Determine the composition of Cu-en complex by Job's method, Determine the λmax for Ni-en complex[(1:1), (1:2),(1:3)] complex, Determine the composition of Ni-en complex by Job's method.

Course outcomes:

Students will learn and apply basic techniques for analysis of different compounds like alloy, composition of complexes using various methods.

Organic Chemistry Practical -III

Isolation of natural products

1. Isolation of Caffeine from tea leaves.
2. Isolation of piperine from black pepper.

Preparation of industrially important compounds by following Name reactions.

1. Riemer-Tiemann reaction (Salicyladehyde from phenol)
2. Skraup synthesis (Quinoline from aniline)

Green Synthesis

1. Green approach for preparation of benzopinacolone from benzopinacol using iodine catalyst.
2. Bromination of trans-stilbene using sodium bromide and sodium bromated.
3. [4+2] cycloaddition reaction in aqueous medium at room temperature.
4. Benzil Benzilic acid rearrangement under solvent free condition.

Organic Estimations.

1. non-aqueous titration of Sodium Benzoate.
2. Estimation of Isoniazid.
   - Perform at least 8 practicals out of these.

Course outcomes:

Students will learn and apply basic techniques used in the organic laboratory for preparation, purification and identification of organic compounds. Students will employ the major techniques used in organic chemistry laboratories for analyses such as melting point determination, extraction, chromatography, distillation and chemical characterization tests. Students will synthesize organic compounds and identify the corresponding alteration in the functional groups. Students will correctly calculate reaction yield for relevant lab experiments.

Reference Books

- Comprehensive Practical Organic Chemistry by V.K. Ahluwalia and Ren Aggarwal
- Monograph on Green Chemistry Laboratory Experiments by Green Chemistry Task Force Committee, DST
- Quantitative analysis by Arther I.Vogel
- Quantitative analysis by V.K. Ahluwalia
- Quantitative analysis by Mann and sanders

Core Course

CH21210
Physical and Analytical Chemistry Practical-III (Credit-2)

1. Effect of substitution of weak aliphatic acid (CH3COOH) on its Ka.
2. Effect of substitution of weak aromatic acid (Benzoic Acid) on its Ka.
3. Determine the amount of Fe(III) using EDTA by spectrophotometry.
4. Cloud point of nonionic surfactant Triton X-100.
5. Potentiometric determination of Cl- and I- in a mixture by standard AgNO3
6. Energy of activation of different liquids using Viscometer.

Analytical Chemistry Practical-III (Any Six)

1. Analysis of Cu^{+2} and Ni^{+2} in German Silver Alloy.
2. Determination of percentage of Cr and Mn in Steel Sample.
3. Separation of Zn^{+2} and Mg^{+2} by anion exchange chromatography.
4. Analysis of Ultramarine sample for the major constituent.
5. Analysis of Portland cement for the major constituent.
6. Determination of saponification value of Oil and fat.
7. Determination of Iodine value of Oil and fat.
8. Determination of Phenol.
9. Percentage purity of Penicillin/Aspirin.
10. Determination of % purity of Glycerol by periodic oxidation.

Project Work (4 credits)

CH21160

Group-I

Departmental Elective-I

CH24040

Organic Chemistry Specific Topics (Credit 3+1)

Course objective: The main objective of the course will be to enhance the understanding and knowledge of specific topics of Organic Chemistry, for students studying in organic chemistry. By the end of the paper, a student will be able to:

- The chemistry of basic introduction part of five & Six membered Heterocyclic compounds
- Understand the important aspects of reagents for better understanding of organic synthesis
- Learn the chemistry of principles of green chemistry and their applications

Prerequisite:

- Basic terms and fundamental aspects related to heterocyclic compounds
- Basic terms and fundamental aspects related to reaction mechanism
- Basic terms and fundamental aspects related to reactions, pollution & stoichiometry of chemistry

Unit-I Heterocyclic Chemistry-I

(A) Nomenclature of Heterocycles: Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles. Structure, reactivity and synthesis of reduced three membered Heterocycles: (a) Oxirane: Sharpless method, Shi epoxidation, Jacobsen epoxidation, etc, (b) Thiirane (c) Aziridine. Structure, reactivity and synthesis of reduced four membered Heterocycles: (b) Oxetane (b) Thietane (c) Azetine

Unit-II Heterocyclic Chemistry-II

(A) Nomenclature of Heterocycles: Hantzsch-Widman nomenclature systems for monocyclic and fused heterocycles and bridged heterocycles

(B) Five and six membered heterocycles with two hetero atoms: Synthesis, reactivity, aromatic character and importance of following heterocyclic rings: Oxazole, Thiazole, Pyrazole, Imidazole, Pyridazine, Pyrimidine, Pyrazine

(C) Condensed five membered heterocycles: Synthesis, reactivity, aromatic character and importance of following heterocyclic Rings: Benzoxazole, Benzthiazole, Benzopyrazole, Benzimidazole

Unit-III Reagents for Organic Synthesis

Introduction, Preparation and Industrial Applications of the following, (1) N-Bromosuccinimide (NBS) (2) Grubbs 1st and 2 generation catalyst (3) N,N-

dicyclohexylcarbodiimide (DCC) (4)Lead tetra-acetate (LTA) nd (5)Baker's yeast (6)n-butyllithium (7)K3Fe(CN)6 and DMSO (8)Grignard Reagent (9)Diazomethane (10)Polyphosphoric acid

Unit-IV Green Chemistry

Twelve principles, green solvents and their applications: Ionic liquids, types, properties and applications, ILs as solvents, Supercritical fluids, Supercritical CO, its properties and applications in dry cleaning and decaffeination of coffee. 1. Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). 2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylation reaction).

Reference Books:

- D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
- Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
- One- and Two-dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).
- Organometallic Chemistry by P. L. Pauson (Edward Arnold, 1968).
- Principles of Organometallic Chemistry by Coats, Green, Powell & Wade (Chapman and Hall, 1977).
- An introduction to the chemistry of heterocyclic compounds-R MAcheso
- Heterocyclic Chemistry- J A Joule and Smith
- Heterocyclic chemistry by V. K. Ahluwalia, Narosa publishing house.
- Guidebook to organic synthesis-R K Meckie, D M Smith and R A Atken.
- Ahluwalia, V.K., Kidwai, M.R. New Trends in Green Chemistry, Anamaya Publishers (2005).
- Anastas, P.T. & Warner, J.K, Green Chemistry- Theory and Practical, Oxford University Press (1998).

Course outcomes:

This course can help students to increase their conceptual base and understanding in these topics which will be needed by students in their pursuit of research in organic chemistry and other allied branches of chemistry

Departmental Elective-II

Group-II

CH24050

Analytical Chemistry (Credit 3+1)

(Departmental Elective-II)

Course objective:

- The aim is to give basic understanding of electro analytical methods and their importance as well as application in various fields of applied chemistry.
- To learn the importance of various electrodes and their applications
- To gain the understanding of Chromatographic separation methods

Prerequisite:

- Introductory knowledge of Aspects of Electrochemistry
- Basic knowledge of Chromatography
- General Concepts of Electrolysis

Unit-I: Electrical Methods of Analysis

Electrogravimetry, Constant Potential and current Electrolysis, Factors affecting the quality of deposits, Applications. Principle of Coulometry, Controlled current coulometry, Instrumentation and application of Controlled potential coulometry, Coulometric titrations (primary and secondary), endpoint detection in coulometry titration, applications of Coulometric Titrations, Comparison of Coulometric and Volumetric Titration

Unit-II: Ion Selective Electrodes

Classification of ion selective electrodes, Solid state electrodes – Glass electrode effect of glass structure on selectivity function of the glass electrode. Acid error, Alkali error, silver halide, Sulphide, Lanthanum fluoride ion selective electrodes. Gas electrodes, ammonia, sulphur dioxide, oxygen and CO_2 sensing electrode, Application

Unit-III: Separation Techniques

Introduction, Classification of Chromatographic Techniques, Column Chromatography: Introduction, Apparatus, Adsorbent, Solvent, Preparation of The Column, Detectors, Method of introducing the solution and analysis, Column Characteristic, Application of separation leaf pigments, mixture of dyes, racemic mixture etc. Thin Layer Chromatography: Superiority of TLC over other Chromatographic Techniques, Experimental Techniques, Application of TLC, Limitation, HPTLC principle, technique, applications.

Reference Book:

- Vogel's Text book Quantitative Chemical Analysis 5th edition by G.H.Jeffery, J. Bassett, J. Mendham, R.C. Denney.
- Principles of Instrumental Analysis: D.A. Skoog, Holler and Crouch (Cengage lerning, 7th edition)
- D.A. Scoog, D.M. West and James Haller, Fundamentals of Analytical Chemistry, 7th Ed
- R.A. Day and A. L. Underwood, Quantitative analysis, 5th ed, Prentice Hall of India Pvt. Ltd., New Delhi.
- Gurdeep R. Chatwal, Sham Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- G L David Krupadanam et al., Analytical Chemistry, Universities Press (India) Limited 2001.
- Raghupati Mukhopadhyay, Pratul Chatterjee, Advanced Practical Chemistry, Books and Allied Pvt. Ltd.

Course outcomes:

This course can be helpful for students to increase their application-based understanding in these topics which will be needed by students in their pursuit of Analytical chemistry and other applied branches of chemistry.