UNIVERSITY OF DELHI

CNC-II/093/1(31)/2023-24/10

Dated: 03.04.2024

NOTIFICATION

Sub: Amendment to Ordinance V

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of BSc. Analytical Chemistry – Chemistry Component (Kirori Mal College) for Semester-IV based on Under Graduate Curriculum Framework - 2022 implemented from the Academic Year 2022-23 is notified for information of all concerned;

SEMESTER-IV

BSc. Analytical Chemistry (Kirori Mal College)

1. Discipline Specific Core (DSC)
   (i) Separation methods-II
   (ii) Functional group
2. Discipline Specific Elective (DSE)
   (i) Conductance, Electrochemistry and Chemical Kinetics

Syllabus alongwith credit distribution is enclosed at ***Annexure-1***

REGISTRAR

Annexure-1

BSc. (Analytical Chemistry)
(Analytical and Chemistry Component)

Kirori Mal College

SEMESTER IV

DISCIPLINE SPECIFIC CORE COURSE-10

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
SEPARATION METHODS-II; ANALYTICAL CHEMISTRY-4 (AC4)	4	2	0	2	Class 12th with Physics, Chemistry, Mathematics	Studied SEPARATION METHODS-I

Learning Objectives: Objective of this course is to learn the separation techniques and its application.

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

- Demonstrate and understand various types of separation techniques and their applications
- Demonstrate and understand Electrophoretic techniques
- Apply these aforementioned techniques

SYLLABUS OF DSC- 10

THEORY COMPONENT-

UNIT 1: **(20 Hours)**

COLUMN CHROMATOGRAPHY

A. General: columns, matrix materials, stationary phase, column packing, application of sample, column development and sample elution, detectors and fraction collectors, applications.

B. High performance liquid chromatography: Principle, column, matrices and stationary phases, column packing, mobile phase and pumps, application of sample, detectors, applications.

C. Adsorption chromatography: Principle, adsorbents, solvents, nature of solute, operating parameters, retention volumes and times, applications.

D. Liquid-liquid partition, chromatography: Principle, normal phase chromatography, reversed phase liquid chromatography, applications.

E. Ion-exchange chromatography: Principle, ion exchangers, ion- exchange equilibria, ion-exchange resin selectivity, column operations (column development, detection of solute bands), factors affecting retention volumes, applications.

F. Gel chromatography: Principle, types of gels, separation by gel chromatography, applications.

UNIT 2: **(10 Hours)**

ELECTROPHORETIC TECHNIQUES:

A. Principle, apparatus, support media (paper, cellulose acetate membranes, gels)

B. SDS-PAGE, native gels, gradient gels, isoelectric focusing, 2D-PAGE, continuous flow electrophoresis, detection, estimation and recovery of proteins in gels.

C. Western Blotting, Electrophoresis of Nucleic Acids, Capillary Electrophoresis.

D. Isoelectric Focusing.

PRACTICAL COMPONENT **(60 Hours)**

1. Determination of the residual chlorine in city water supply using colorimetry (*Take at least two samples*).
2. Determination of adsorption isotherm of acetic acid on activated charcoal and determination of the adsorption constant (k).
3. Determination of the capacity of at least two anion exchange resins *e.g.* Amberlite type II (Dimethyl-2-hydroxyethylbenzyl ammonium-based and Amberlite type I trialkyl ammonium-based, DOWEX type II, etc.
4. Determination of the capacity of at least two cation exchange resins *e.g.* DOWEX-50 (sulphonic acid based), sodium polystyrene sulfonate, Amberlite-sulphonic acid based, *etc*).
5. To remove the hardness of the water by using ion exchange resins.
6. To separate Ni (II) and Zn (II) by ion exchange resins and quantify it by complexometric titration.
7. Determination of the solubility of $CaSO_4$ by ion exchange and complexometric titrations.
8. Separation of compounds using adsorption column chromatography.

(a) Separation of the mixture of *o*-nitro phenol and *p*-nitro phenol.

(b) Separation of the mixture of dyes (methylene blue and methyl orange).
(c) Separation of the mixture of *o*-nitro aniline and *p*-nitro aniline.
9. Determination of the void volume of a gel column.
10. Visit to Water Purification Plants.

ESSENTIAL/RECOMMENDED READINGS

- Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D. Van Nostrand Company Inc.
- Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K.; (2000), Vogel's Quantitative Chemical Analysis, Prentice Hall.
- Wilson, K.; Walker, J. (2000),Principles and Techniques of Practical Biochemistry, Cambridge University Press. Additional Resources:
- Holme, D.J.; Peck, H. (1998),Analytical Biochemistry, Prentice Hall.
- Freifelder, D. (1983),Physical Biochemistry, W.H.Freeman & Company.
- Plummer, D.T.(2001),Introduction to Practical Biochemistry, McGraw-Hill.

SUGGESTIVE READINGS

- Holme, D.J.; Peck, H. (1998),Analytical Biochemistry, Prentice Hall.
- Freifelder, D. (1983), Physical Biochemistry, W.H.Freeman & Company.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC CORE COURSE-11

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FUNCTIONAL GROUP ORGANIC CHEMISTRY-I; CHEMISTRY-4 (C4)	4	2	0	2	Class 12th with Physics, Chemistry, Mathematics	NIL

Learning Objectives:
To establish the concept, structure, methods of preparation and reactions for the following classes of compounds:
alkyl and aryl halides, alcohols, phenols and ethers, aldehydes and ketones.

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

- Explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Identify many organic reaction mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, and electrophilic substitution.
- From the Practical Component, the student will be able to identify qualitatively the various classes of organic compounds, prepare their derivatives, confirm the functional groups .

SYLLABUS OF DSC- 11

THEORY COMPONENT-

Unit I: **(Hours 14)**

Alkyl and Aryl Halides

A) Alkyl halides (upto 5 carbons):

Structure of haloalkanes and their classification as 1^0, 2^0 & 3^0.

Preparation: starting from alcohols (1^0, 2^0 & 3^0) and alkenes with mechanisms.

Reactions: Nucleophilic substitution reactions with mechanism and their types (SN^1, SN^2 and SNi), Competition with elimination reactions (elimination vs substitution), nucleophilic substitution reactions with specific examples from hydrolysis, nitrite and & nitro formation, nitrile & isonitrile formation and Williamson's ether synthesis.

Grignard reagent and its synthetic applications

B) Aryl halides:

Structure and resonance
Preparation: Methods of preparation of chloro, bromo & iodo-benzene from benzene (electrophilic substitution), from phenols (nucleophilic substitution reaction) and from aniline (Sandmeyer and Gattermann reactions).
Reaction: Nucleophilic aromatic substitution by OH group (Bimolecular Displacement Mechanism), Effect of nitro substituent on the reactivity of haloarenes, Reaction with strong

bases $NaNH_2/NH_3$(elimination-addition mechanism involving benzyne intermediate), relative reactivity and strength of CX bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit II: **(16 Hours)**

Alcohols, Phenols, Ethers (Aliphatic and Aromatic)

A) **Alcohols (upto 5 Carbon):**

Structure and classification of alcohols as 1^0, 2^0 & 3^0.

Preparation: Methods of preparation of 1^0, 2^0 & 3^0 by using a Grignard reagent, ester hydrolysis and reduction of aldehydes, ketones, carboxylic acids and esters.

Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer Oxidation.

B) **Diols** (upto 6 Carbons): Oxidation and Pinacol-Pinacolone rearrangement.

C) **Phenols**: acidity of phenols and factors affecting their acidity.

Preparation: Methods of preparation from cumene, diazonium salts and benzene sulphonic acid.

Reactions: Directive influence of OH group and Electrophilic substitution reactions, viz. nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation, reaction due to OH group: Schotten-Baumann reaction

D) **Ethers** (Aliphatic & Aromatic):

Williamson's ether synthesis, Cleavage of ethers with HI

E) **Aldehydes and ketones (Aliphatic and Aromatic):**

Preparation: from acid chlorides and from nitriles.

Reactions: Nucleophilic addition, nucleophilic addition – elimination reaction including reaction with

HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol Condensation, Cannizzaro's reaction,

Wittig reaction, Benzoin condensation, Clemmensen reduction, Wolff Kishner reduction, Meerwein-PondorffVerley reduction.

PRACTICAL COMPONENT **(60 Hours)**

Systematic qualitative identification and derivative preparation of organic compounds. following functional groups containing compounds should be provided: alcohols, phenols, carbonyl compounds and carboxylic acids (mono- and dicarboxylic both). (*Provide few organic compounds containing at least one extra element*)

ESSENTIAL/RECOMMENDED READINGS

Theory:

- Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7 th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. (2002), Organic Chemistry (Volume 1), 6 th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K. International.
- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2017), Organic Chemistry, 12th Edition, Wiley

Practical:

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
- Mann, F.G.; Saunders, B.C.(2009), Practical Organic Chemistry, Pearson Education.
- Dhingra,S; Ahluwalia V.K., (2017), Advanced Experimental Organic Chemistry, Manakin Press.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC ELECTIVES (DSE)

CREDIT DISTRIBUTION, ELIGIBILITY, AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CONDUCTANCE, ELECTROCHEMISTRY AND CHEMICAL KINETICS; CHEMISTRY-2 (C2)	4	2	0	2	Class 12th with Physics, Chemistry, Mathematics	NIL

Learning objectives: In electrochemical cells the students will learn about electrolytic and galvanic cells, measurement of conductance and its applications, measurement of emf and its applications. The student will also learn about the reaction rate, order, activation energy and theories of reaction rates.

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

- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Demonstrate the importance of Nernst equation, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.
- Demonstrate rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic.

SYLLABUS OF DSE- C2

THEORY COMPONENT-

Unit 1: **(08 Hours)**

Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Arrhenius theory of electrolytic dissociation, Kohlrausch Law of independent migration of ions, Ionic velocity, mobility and their determination, transference number and its relation to ionic mobility, determination of transference number using Hittorf

and Moving Boundary methods. Applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit 2: **(12 Hours)**

Electrochemistry

Review of reversible and irreversible cells, standard electrode potential, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells, liquid junction potential and salt bridge, pH determination using hydrogen electrode and quinhydrone electrode, Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Unit 3: **(10 Hours)**

Chemical Kinetics and Catalysis

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants), half–life of a reaction, general methods for determination of order of a reaction, Concept of activation energy and its calculation from Arrhenius equation. Theories of reaction rates: Collision theory and activated complex theory of bi-molecular reactions. Comparison of the two theories (qualitative treatment only) Catalysis: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

PRACTICAL COMPONENT **(60 Hours)**

Conductance

1. Determination of molar conductance, degree of dissociation and dissociation constant of a weak acid.
2. Perform the following conductometric titrations: **a**) Strong acid *vs* strong base **b**) Weak acid *vs* strong base. **c**) Mixture of strong acid and weak acid *vs.* strong base. Standardisation of solutions and volumetric comparison is to be done.

Potentiometry

3. Perform the potentiometric titrations of
   a) Strong acid vs strong base
   b) Weak acid vs strong base.
   c) Potassium dichromate vs. Mohr's salt Chemical Kinetics

Standardisation of solutions and volumetric comparison is to be done.
4. Study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid.
5. Study the kinetics of Iodide-persulphate reaction by Initial rate method or integrated rate law method.
6. Effect of substrate concentration on acid phosphatase activity and determination of its K_m, V_{max} and K_i (with respect to inorganic phosphate).

ESSENTIAL/RECOMMENDED READINGS

Theory:

- Castellan, G. W .(2004),P hysical Chemistry, Narosa.
- Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.1, 6th Edition, McGraw Hill Education.
- Kapoor, K.L. (2015), A Textbook of Physical Chemistry, Vol.5, 3rd Edition, McGraw Hill Education.
- Puri, B.R., Sharma, L.R. and Pathania M.S. (2020), Principles of Physical Chemistry, Vishal Publishing Co.

Practical:

- Khosla, B.D.; Garg, V.C.; Gulati, A.(2015), Senior Practical Physical Chemistry, R. Chand & Co.
- Kapoor, K.L. (2019), A Textbook of Physical Chemistry, Vol 7, 1st Edition, McGraw Hill Education.
- Batra, S.K., Kapoor, V and Gulati, S. (2017) 1 st Edition, Experiments in Physical Chemistry, Book Age series.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.