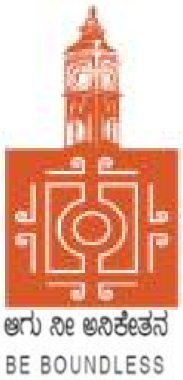

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course- as per NEP 2020)

Syllabus for B.Sc. Chemistry
(III & IV Semester)

2022-23 onwards

Proceedings of the Meeting of Board of Studies in Chemistry (UG) Bengaluru City University held on 30th Sep 2022 at 10.30 am in the Department of Chemistry, Central College Campus, Bengaluru-560 001

The Chairperson welcomed the members of the Board to the meeting and placed the agenda before the Committee for discussion.

Agenda 1: As per the directive from the Bengaluru City University, the Chemistry syllabus for the B. Sc., degree programme as per NEP model II A model programme structure for the **Third and Fourth semester** B.Sc. (Honors) Chemistry course undergraduate programs in universities and colleges [subjects with practicals] was prepared. The proposed syllabus is to be introduced from 2022-23 onwards after the approval from different bodies.

Agenda 2: Chairperson informed that syllabus has to be made in such a way that,

- The rules governing the NEP II A model (semester scheme) for UG program to be followed are as per the university guidelines.
- To equip and strengthen students with analytical skills needed for their careers in teaching, industry, and research.
- With the changing trends and latest developments in research updating of the curriculum is a necessary exercise.

Agenda 3: Scrutiny and approval of the Syllabus (theory and practical) and Scheme of Examination under NEP model (Semester Scheme) for the Chemistry Course in B.Sc., Degree Programme was finalized and approved in the BOS Meeting.

The Board of Studies (UG) approved the Syllabus after appropriate modifications for the Chemistry Course **Third and Fourth semester** in B. Sc., Degree Programme starting from the academic year 2022-23.

Agenda 4: Approval of Board of Examiners list (Chemistry UG) for the academic year 2022-23.

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The Chairperson recorded her thanks to the teachers involved in the preparation of this syllabus.

The following BOS members were present.

Name of members of BOS	Signature
1. Dr. Mahesh Aravind	
2. Dr. Rita Battacharjee	
3. Dr. Vasundara D E	— ABSENT —
4. Dr. S Kantharaju	— ABSENT —
5. Prof. Shiva Prakash M	
6. Dr. Nanjundappa V S	— ABSENT —
7. Dr. Prasanna Kumar	
8. Dr. Ramakrishna Reddy K	30/09/22
9. Dr. Ronald J Mascarenhas	— ABSENT —
10. Prof. V R Devraj	
11. Prof. Hariprasad. S.	30.9.22
12. Dr. V Gayathri. Professor and Chairperson	

Dr. V. GAYATHRI
Professor & Chairperson
Department of Studies in Chemistry
Bengaluru City University
Central College Campus
BENGALURU - 560001.

CHEMISTRY DSC-3: Analytical and Organic Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Credit Points :4

Evaluation: Continuous Internal Assesment-40 Marks

Semester End Examination **-**60 Marks

Course Objectives:

1) Interrelationship among frequency, wavelength and wave number and importance of validation parameters of an instrumental method will be taught
2) Principle, instrumentation and applications of spectrophotometry, nephelometry and turbidometry will be taught
3) Fundamentals of separation methods and principles of paper, thin layer and column chromatography will be taught
4) Principle, types and applications of solvent extraction will be taught
5) Principle and mechanism of ion-exchange, types of resins and domestic and industrial applications of ion-exchange chromatography will be taught
6) The concept of mechanism and its importance will be taught to the student
7) Concept and importance of intermediates in organic chemistry will be taught taking proper examples
8) The various techniques for identification of reaction mechanism will be taught to the student taking proper examples
9) Concept of stereochemistry and its importance will be taught.
10) The various projection formulae and the techniques of designating the molecules into R, S, D, L will be taught taking proper examples
11) The theory and concept of Cis-, Trans- isomerism and its importance and the techniques to differentiate between them will be taught taking examples

Course Specific Outcomes

After the completion of this course, the student would be able to

1) Understand the importance of fundamental law and validation parameters in chemical analysis
2) Know how different analytes in different matrices (water and real samples) can be determined by spectrophotometric, nephelometric and turbidometric methods.
3) Understand the requirement for chemical analysis by paper, thin layer and column chromatography.
4) Apply solvent extraction method for quantitative determination of metal ions in different samples
5) Utilize the ion-exchange chromatography for domestic and industrial applications
6) Explain mechanism for a given reaction.
7) Predict the probable mechanism for a reaction. Explain the importance of reactive intermediates role and techniques of generating such intermediates
8) Explain the importance of Stereochemistry in predicting the structure and property of organic molecules.
9) Predict the configuration of an organic molecule and able to designate it. 10)Identify the chiral molecules and predict its actual configuration

Unit-I

Quantitative Analysis-Instrumental methods

Electromagnetic spectrum, absorption of electromagnetic radiation, Definition and units of frequency, wavelength, wave number,

Beer-Lambert law and its derivation, deviations, limitations, construction of calibration graph (Plot of absorbance vs concentration). Evaluation Procedures- standard addition, Internal standard addition, validation parameters-detection limits, sensitivity, linearity, Instrumentation, single beam and double beam spectrophotometers, quantitative applications of colorimetry (determination of Fe, Cu, Ti and PO_4^{3-}). Numerical problems

10 hrs.

Nephelometry and Turbidometry: Introduction, principle, instrumentation of nephelometry and turbidometry; effects of concentration, particle size and wavelength on scattering, choice between nephelometry and turbidometry, Applications of nephelometry and turbidometry (determination of SO_4^{2-} and PO_4^{3-})

4 hrs.

Unit-II

Separation methods

Fundamentals of chromatography: General description, definition, terms and parameters used in chromatography, classification of chromatographic methods, criteria for selection of stationary and mobile phases and nature of adsorbents.

Column chromatography. Principle- Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

3hrs

Paper chromatography: Principle and applications

Thin layer chromatography (TLC): Principle, Mechanism, Rf value, efficiency of TLC plates, methodology–selection of stationary and mobile phases, plate development, spray reagents, identification of analytes, qualitative applications. **4 hrs.**

Ion exchange chromatography: Principle resins, types with examples- cation exchange and anion exchange resins, mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications).

3hrs

Solvent Extraction: Principle,Types- batch, continuous, efficiency, selectivity, distribution coefficient, Nernst distribution law, derivation, factors affecting the partition, relationship between % extraction and volume fraction, Numerical problems.

Solvent extraction of lanthanides, iron and copper.

4hrs

Unit-III

Reactive Intermediates: Generation, Stability and Reactions of, i) arbocations ii) Carbanions iii) Free Radicals iv) Carbenes and Nitrenesv) Arynes.

Applications:

i) Carbocations: Dienone-phenol; and Pinacol-Pinacolone Rearrangement.

ii) Carbanions: Perkin Reaction, Aldol condensation, Claisen-Schmidt condensation.

iii) Free Radicals: Sand meyer Reaction

iv) Carbenes and Nitrenes: Singlet and triplet states, relative stability and reactions: addition to Carbon-Carbon double bond

v)Arynes: Formation, Diels-Alder reaction to dienes

8hrs.

Methods for Identifying Reaction Mechanisms:

Product analysis- Isolation and identification of intermediates, Stereo chemical evidences effect of catalyst, crossover experiments, Isotopic studies, Kinetic Studies

6 hrs.

Unit-IV

Stereochemistry of Organic Compounds:

Fischer - , Newman and Sawhorse projection formulae and their interconversions.

Geometrical isomerism: Cis-trans and syn-anti isomerism, E/Z notations. Optical Isomerism: Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral centers, Diastereoisomers, meso structures, Racemic mixtures and Resolution, Relative and absolute configuration, D/L and R/S designations (for single carbon stereo centers) with CIP rules

14 hrs.

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch Ninth edition. Saunders College Publishing, New York (2014).
2. Analytical Chemistry, G.D. Christian, 6th edition, John Wiley & Sons, (2007)
3. Analytical Chemistry, 7th Edition: Seventh Edition Gary D. Christian, Purnendu (Sandy) Dasgupta, Kevin Schug Wiley Global Education, (2013)
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, PHI Learning Pvt Ltd. New Delhi (2015).
5. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, Pearson Education Pvt. Ltd. (2007).
6. Organic Reaction Mechanism by V.K. Ahluwalia and R.K. Parashar (Narosa Publishers) [2002],
7. Organic Chemistry by S.M. Mukherji, S.P. Singh and R.K. Kapoor New age publishers (2017)
8. Organic Chemistry by Robert T. Morrison, Robert N. Boyd Dorling Kindersley (India) Pvt Ltd. Pearson Education India; 7th edition (2010)
9. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008)
10. Organic Chemistry by FINAR (Vol I and II) Pearson Education India; 6th edition (2002)
11. Introduction to Organic Chemistry by John E. McMurry CENGAGE LEARNING (RS); 9th edition (2008)
12. Stereochemistry of Organic Compounds Ernest L. Eliel, Samuel H. Wilen. Wiley publishers; 1st edition (2008)
13. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient
14. Solomons, T.W G., Fryhle, B. Craig. Organic Chemistry, John Wiley & Sons, Inc (2009).

PRACTICALS (III SEMESTER)

Credit Points: 2 **Teaching Hours:4 hrs.**

Evaluation: Continuous Internal Assessment- :25 marks

Semester End Examination :25 marks

Course Objectives

1) To impart skills related to preparation of stock and working solutions and handling of instrumental methods
2) To know the principle of colorimetric analysis and construction of calibration plot
3) To understand the chemistry involved in colorimetric determination of metal ions and anions
4) To determine Rf values of different metal ions present in a mixture
5) To impart knowledge on the importance of functional groups in organic compounds.
6) Techniques to identify the functional groups in an compound by performing physical and chemical tests
7) To record its melting point/boiling point.
8) To prepare suitable derivative for that compound and to characterize it.

Course Specific outcomes

After the completion of this course, the student would be able to

1) Understand the importance of instrumental methods for quantitative applications
2) Apply colorimetric methods for accurate determination of metal ions and anions in water or real samples
3) Understand how functional groups in an compound is responsible for its characteristic property
4) Learn the importance of qualitative tests in identifying functional groups.
5) Learn how to prepare a derivative for particular functional groups and how to purify it'

PART-A (Analytical Chemistry)

1) Colorimetric determination of copper using ammonium hydroxide.
2) Colorimetric determination of iron using thiocyanate
3) Colorimetric determination of nickel using DMG
4) Colorimetric determination of titanium using hydrogen peroxide
5) Colorimetric determination of nitrite in water sample (diazo coupling Reaction using Griess reagent
6) Colorimetric determination of phosphate as ammonium phosphomolybdate
7) Measurement of Rf values of two component systems by TLC (ortho and para nitro anilines)
8) Separation of different metal ions by paper chromatography (Co, Ni, and Cu) or
   Solvent extraction of iron using oxine (demonstration)

PART-B (Organic Chemistry)

Qualitative analysis of Organic compounds.

1) Salicylic acid,2) Glucose 3) Methyl salicylate

4)p-Amino benzoic acid, 5) p-Chloro benzoic acid 6) Salicylaldehyde,

7)Acetophenone, 8) Benzoic acid 9) Salicylamide 10) Benzamide etc.

(Atleast 6-8 compounds to be analyzed in a semester)

References

1) Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6^{th} edition, Third Indian Reprint, Pearson Education Pvt.Ltd.(2007)
2) Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4) Ahluwalia, V.K. &Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000)

CHEMISTRY DSC-4: Inorganic and Physical Chemistry-II

Contact Hours: 56 **Work load: 4 Hours/Week.**

Credit Points :4

Evaluation: Continuous Internal Assessment -40 Marks

Semester End Examination -60 Marks

Course Objectives:

Students learn about

1. Different types of bonding in molecules/compounds/ions
2. The structures of molecules/compounds/ions based on different models/theories
3. Properties of compounds based on bonding and structure
4. The fundamentals of thermodynamics including the laws, the concept of entropy and free energy functions and their applications.
5. The concepts of surface chemistry, catalysis and their applications.
6. The theoretical and experimental aspects of chemical kinetics including basic theories of reaction rates and methods of determining order.
7. Electrochemistry dealing with electrolytes in solution. Conductance measurements and applications. Concept of ionic mobility and their determination.

Course outcomes:

After the completion of this course, the student would be able to

1. Predict the nature of the bond formed between different elements
2. Identify the possible type of arrangements of ions in ionic compounds
3. Write Born - Haber cycle for different ionic compounds
4. Relate different energy parameters like, lattice energy, entropy, enthalpy and solvation energy in the dissolution of ionic solids
5. Explain covalent nature in ionic compounds
6. Write the M.O. energy diagrams for simple molecules
7. Differentiate bonding in metals from their compounds
8. Learn important laws of thermodynamics and their applications to various thermodynamic systems
9. Understand adsorption processes and their mechanisms and the function and purpose of a catalyst

10. Apply adsorption as a versatile method for waste water purification.
11. Understand the concept of rate of a chemical reaction, integrated rate equations, energy of activation and determination of order of a reaction based on experimental data
12. Know different types of electrolytes, usefulness of conductance and ionic mobility measurements
13. Determine the transport numbers

Unit - I

Structure and Bonding -I

The ionic bond:

Structures of ionic solids, Radius ratio rules and its limitations: Calculation of some limiting radius ratio, Coordination number 3 (planar triangle), 4 (tetrahedral and square planar) and 6 (octahedral), Close packing. **3hrs**

Classification of ionic structures:

Ionic compounds of the types AX (ZnS, NaCl, CsCl), AX_2 (Calcium fluoride: fluorite) and Rutile structure.

Layer structures :CdI_2, **2hrs**

Lattice energy and Born-Haber cycle, Derivation of Born-Lande equation and its drawbacks, Kapustinskii equation, solvation energy and solubility of ionic solids, polarizing power and polarizability, Fajan's rules with applications.

Numerical problems **4 hrs.**

Covalent bond: Valence bond theory, The Lewis theory, The octet rule, Exceptions to the octet rule, Sidgwick- Powell theory. Valence shell electron pair repulsion (VSEPR) theory, effect of lone pairs, electronegativity, isoelectronic principle, examples using VSEPR theory: $BF_3$and BF_4^-, $NH_3$and NH_4^+, H_2O, PCl_5, ClF_3, SF_4, SF_6, and $\underline{IF_7}$.
Limitations of VSEPR theory. **5 hrs.**

Unit - II

Structure and Bonding -II

Concept of resonance, resonance energy, hybridization, types of hybridization, sp, sp^2, sp^3 dsp^2 dsp^3, d^2sp^3, sp^3d^2 with one example each, and energetics of hybridization.

Bent's rule, Limitations of Valence Bond Theory.

3 hrs.

Molecular Orbital theory:

LCAO concept: s-s, s-p, p-p, p-d and d-d combinations of orbitals, bonding, nonbonding and antibonding molecular orbitals, non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals

Examples of molecular orbital treatment for Homonuclear diatomic molecules and ions. H_2 and H_2^+, He_2 and He_2^+, Li_2, Be_2, B_2, C_2, N_2, and N_2^+, O_2, O_2^- and O_2^{2-}

M.O. energy diagrams of heteronuclear diatomic molecules with examples (NO, NO^+, CO and HCl). Calculation of bond order, relationship between bond order, bond energy and bond length, magnetic properties based on MOT.

7 hrs.

Metallic Bonding:

General properties of metals: conductivity, lustre, malleability and cohesive force

Crystal structures of metals and bond lengths.

Theories of bonding in metals:

Free electron theory, Valence bond theory, Molecular orbital or band theory of solids

Prediction of conducting properties of conductors, insulators and semiconductors, extrinsic and intrinsic semiconductors using M.O. theory.

4 hrs.

UNIT III

First Law of Thermodynamics

Thermodynamic processes, Reversible and Irreversible Processes, nature of Heat and work, internal energy, First Law of thermodynamics, Enthalpy of a System, Work done in isothermal and adiabatic expansion of an ideal gas, Numerical problems, Joule - Thomson expansion, Relation between Joule-Thomson coefficient and other thermodynamic parameters.

Second law of Thermodynamics

Concept of entropy, thermodynamic scale of temperature, Statements of the Second law of Thermodynamics, molecular and statistical interpretation of entropy,

Calculation of entropy change for reversible and irreversible processes, Free Energy Functions: Gibbs and Helmholtz energy, Variation of S, G, A with T, V and P, Numerical problems, Free energy change and spontaneity, Gibbs-Helmholtz equation.

Third Law of Thermodynamics

Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. **09 hrs.**

Surface Chemistry

Adsorption

Types of adsorption isotherms. Freundlich adsorption isotherm (only equation), its limitations. Langmuir adsorption isotherm (derivation to be done) and BET equation (derivation not included).

Catalysis

Types of catalysis and theories with examples (intermediate compound theory and adsorption theory), Theory of acid base catalysis, Michaelis-Menten mechanism. Heterogeneous catalysis: surface reactions, unimolecular, bimolecular surface reactions. Autocatalysis with examples. Applications: Design process to removal of toxic compounds from industrial wastewater and treatment of portable water requirements. **5hrs**

UNIT IV

Chemical Kinetics

Differential and integrated form of rate expressions up to second order reactions, Derivationof expression of rate constant of second order reaction (a=b and a ≠ b), Problems on rate constant (a=b), Methods of determination of order of a reaction, temperature dependence of reaction rates; Arrhenius equation, activation energy, Numerical problems on Arrhenius equation in calculating energy of activation and rate constants. Collision theory of reaction rates, Lindemann's mechanism, qualitative treatment of the theory of absolute reaction rates. Experimental determination of

kinetics of (i) inversion of cane sugar by polarimetric method (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

7 hrs.

Electrochemistry – I

Arrhenius theory of electrolytic dissociation. Merits and Demerits, Conductance, Specific conductance, equivalent and molar conductivity and their variation with dilution. Molar conductivity at infinite dilution. Numerical problems.

Kohlrausch's law of independent migration of ions and its applications, Debye-Huckel- Onsager equation. Ionic mobilities and their determinations, transference numbers and their relation to ionic mobility's, determination of transference numbers using Hittorf and Moving boundary methods.

Applications of conductance measurement: (i) degree of dissociation of weak electrolytes (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts (iv) conductometric titrations (acid base titrations only) and (v) Hydrolysis constants of salts. Numerical problems.

7 hrs.

Reference Books.

1. Peter Atkins & Julio De Paula, Physical Chemistry, 9th Ed., Oxford university Press (2010)
2. G W Castellan, Physical Chemistry, 4th Ed., Narosa (2004)
3. R G Mortimer, Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009)
4. B R Puri, L R Sharma and M S Pathania, Principal of Physical Chemistry, Vishal Publishing Co.48 edition (2021)
5. B S Bahl, G D Tuli and ArunBahl, Essentials of Physical chemistry, S Chand Publishing; Twenty-eight edition (2020)
6. A S Negi and S C Anand, A textbook of Physical Chemistry, New Age InternationalPublishers. 3rd Edition (2021)
7. B N Bajpai, Advanced Physical chemistry, S Chand and Company ltd. (2001)
8. R L Madan, Chemistry for Degree Students, Semester I, II, III and IV, S Chand and company Ltd. (2020)
9. P L Soni, O P Dharmarha and U N Dash, Textbook of Physical Chemistry, Sultan Chand and Sons. (2007)
10. Ball, D. W. Physical Chemistry Thomson Press, India (2007).

11. Physical chemistry by Samuel Glasstone East-West Press (Pvt.) Ltd. (2006)
12. J.D. Lee Concise Inorganic Chemistry Wiley India Pvt Ltd. (2022)
13. Huheey James E. Inorganic Chemistry: Principles of Structure and Reactivity-Pearson Education India; 4th edition (2006)
14. Cotton and Wilkinson. Advanced Inorganic Chemistry,Wiley; 6th edition (1999)

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PRACTICALS (IV SEMESTER)

Credit Points: 2 **Teaching Hours: 4Hrs**

Evaluation:

Continuous Internal Assessment- **:**25 marks **Semester**

End Examination **:** 25 marks

Course objective: **To attain practical knowledge about:**

1. Analytical skills in detecting the constituents present in unknown samples by systematically carrying out the qualitative analysis.
2. The methods of determining rates of chemical reactions.
3. Designing electrochemical cells and making measurements related to it.
4. Determination of physical characteristics of electrolytes using conductivity measurements in solution.
5. Adsorption phenomenon, mechanism and basic models to explain adsorption.
6. Simple techniques like conductometry to obtain physicochemical parameters of electrolytes.

Course outcomes: **At the end of the course student would be able to**

1. Understand the chemical reactions involved in the detection of cations and anions.
2. Explain basic principles involved in classification of ions into groups in semi-micro qualitative analysis of salt mixture
3. Carryout the separation of cations into groups and understand the concept of common ion effect.
4. Understand the choice of group reagents used in the analysis.
5. Analyse a simple inorganic salt mixture containing two anions and cations
6. Use instruments like conductivity meter to obtain various physicochemical parameters.

7. Apply the theory about chemical kinetics and determine the velocity constants of various reactions.
8. Learn about the reaction mechanisms.
9. Interpret the behaviour of interfaces, the phenomena of physisorption and chemisorptions and their applications in chemical and industrial processes.
10. Learn to fit experimental data with theoretical models and interpret the data

Part A- Inorganic Chemistry Practicals

Qualitative semi-micro analysis of mixtures containing 2 anions and 2 cations. Emphasis should be given to the understanding of different reactions.

The following cations and anions are suggested.

Cations: NH_4^+, Pb^{2+}, Bi^{3+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Co^{2+}, Cr^{3+}, Ni^{2+}, Zn^{2+}, Mn^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+} Mg^{2+}, Na^+, K^+ and Li^+.

Anions: CO_3^{2-}, CH_3COO^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, SO_4^{2-}, $C_2O_4^{2-}$ and PO_4^{3-}

Spot tests and flame tests to be carried out wherever possible.

Part B- Physical Chemistry Practicals

1. Determination of the enthalpy of neutralization of a strong acid with strong base.
2. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.
3. The study of kinetics of potassium persulphate and potassium iodide volumetrically.
4. Determination of velocity constant for acid catalyzed hydrolysis of methyl acetate.
5. Determination of velocity constant for the saponification of ethyl acetate ($a = b$) volumetrically.
6. Determination of equivalent conductivity of strong electrolyte and verification of DHO equation.
7. Determination of dissociation constant of weak acid by conductivity method.
8. Conductometric titration of strong acid and strong base.
9. Conductometric titration of weak acid and strong base.
10. Determination of the hydrolysis constant of aniline hydrochloride conductometrically.
11. Determination of solubility product of sparingly soluble salt conductometrically.

References

1. Vogel's Qualitative analysis, Revised by G. Svehla, Pearson education, (2002)
2. J B Yadav, Advanced Physical Chemistry, Krishna Prakashan Media (P) Ltd, Meerut. (2015)
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
4. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
5. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003)
6. Athawale V. D. and Mathur P. Experimental Physical Chemistry, New Age International (2001)

BSc Semester III –Chemistry (Hons)
with Analytical/ Organic/ Inorganic/ Physical specialization

Title of the Course: Open Elective-3:
ATOMIC STRUCTURE, BONDING AND CONCEPTS IN ORGANIC CHEMISTRY

Contact Hours: 42 **Workload: 3 hours per week**

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks
Semester End Examination - 60 marks

Course Objectives:

- To develop an understanding of principles of Atomic structure
- To know the importance of quantum numbers, writing of electronic configurations and representation of orbitals
- To develop an understanding of the periodic trends
- To understand the nature of bonding and to predict the shapes of molecules
- To construct MO energy level diagrams and predict the properties of molecules
- To understand the formation of sigma and pi bonds and the bond strength.
- To study the classification of organic reactions
- To learn nomenclature preparation and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds

COURSE OUTCOME:

On completion of the course the student will learn and be able to understand/explain

- the concept of atomic sstructure, significance of quantum numbers, filling of electrons of atoms/ions in various orbitals as per rules
- the trends in periodic properties
- the structures of ionic solids, applications of B-H cycle, solubility of compounds and consequences of polarization of ions

- the shapes of molecules/ions based on VSEPR theory
- the construction of MO energy level diagrams and prediction of properties of molecules/ions like bond order, bond energies, bond lengths and magnetic properties.
- the formation of sigma and pi bonds and the bond strength
- the classification of organic reactions
- nomenclature preparation, and reactions of alkanes, alkenes, alkynes and stability of alicyclic compounds.

Unit I

Atomic Structure

History of an atom. Idea of de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, Bohr's model of hydrogen atom and its limitations. Quantum numbers and their importance, atomic orbitals and shapes of s, p, d orbitals, Multi-electron atoms, Aufbau's and Pauli exclusion principle and Hund's multiplicity rule- Electronic configurations of the elements (atomic no. up to 30), effective nuclear charge and shielding.

8 hrs

Periodic Properties

Atomic radius, covalent, ionic and van der Waal radii-explanation with examples. Definition and periodicity of the following properties - ionic radii, ionization potential, electron affinity and electronegativity, methods of determination of electronegativity. Factors affecting the values of ionization energy.

6 hrs

Unit II

Chemical Bonding

Ionic Solids– Ionic structures (NaCl, CsCl, TiO_2, ZnS), radius ratio rule and coordination number, limitation of radius ratio rule, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule and their consequences.

4 hrs

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization with examples and shapes of simple inorganic molecules and ions. Shapes of NH_3, I_3^+, I_3^-, SF_4, ClF_3, IF_5, ICl_2^- and H_2O using valence shell electron pair repulsion (VSEPR) theory, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, physical picture of bonding and antibonding wave functions. Applications of MO theory to explain the stability of homo dinuclear (He_2, N_2, O_2, F_2, C_2) and hetero dinuclear (NO and CO) molecules. Comparison of M.O. and V.B. Models.

7 hrs

Metallic bond-free electron, Band theory – electrical properties of metals, semiconductors and insulators.

Weak interactions – Hydrogen bonding and its consequences, van der Waals forces.

3 hrs

Unit III

Bonding and molecular structure and hydrocarbons

Bonding and molecular structure: Introduction to organic chemistry, atomic orbitals, sigma and pi bond formation-molecular orbital [MO] method, sp, $sp^2$and sp^3 hybridization, bond length, bond dissociation energies and bond angles (open chain

and cyclic compounds). Electronegativity and polarity of the bonds. Classification and reactions of organic compounds (with examples).

7 hrs.

Aliphatic Hydrocarbons: Alkanes, Alkenes and Alkynes

Definition, Nomenclature, preparations (any two methods)

Reactions: Electrophilic, nucleophilic and free radical addition reactions

Alicyclic compounds:

Nomenclature, preparation and stability of cyclopropane, cyclobutane, Cyclopentane and cyclohexane.

7 hrs.

Reference Books:

1. J. D. Lee, Concise Inorganic Chemistry, ELBS (1996)
2. A. K. Das, Fundamental Concepts of Inorganic Chemistry, CBS; 2nd edition (2019)
3. James E. Huheey, Ellen A. Keiter, Richard L. Keiter Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India; 4th edition (2006)
4. Shriver, D.F. & Atkins, P.W Inorganic Chemistry, Oxford University Press (2009)
5. Herbert Meislich Howard Nechamkin and Jacob Sharefkin Schaum's Outline of Organic Chemistry Theory and Problems of Organic Chemistry. McGrawHill Book Co; (1980)
6. Morrison and Boyd, Organic Chemistry, Sixth Edition ,Pearson Education India; 7th edition (2010)
7. I.L. Finar Organic Chemistry Vol. 1 Pearson Education India; 6th edition (2002)

BSc Semester IV –B Sc / B Sc(Honors) with Analytical/ Organic/ Inorganic/ Physical specialization

Title of the Course: Open Elective-4:

Electrochemistry, Corrosion and Metallurgy

Contact Hours: 42 **Workload: 3 hours per week**

Credit Points: 3

Evaluation: Continuous Internal Assessment - 40 marks

Semester End Examination - 60 marks

This course provides a broad introduction to the fundamental principles of electrochemistry, corrosion and metallurgy. The student will gain an understanding of basic and practical applications in various fields of electrochemistry, corrosion and metals and alloy behaviour and manufacturing processes. This course is a valuable prerequisite for taking more technically challenging courses that will be required for career development.

Course Objectives This course will deal with

1. Types of conductance, concept of electrolytes, electrolysis, redox reactions and EMF
2. Concept of different types of electrochemical cells, Types of electrodes and electrode potential. Application of electrochemical series.
3. Basic principles and applications of conductometric, potentiometric and pH titrations.
4. Different types of Batteries their principle construction and working - lead-acid storage and lithium ion battery. Study of Fuels cells.
5. Concept of corrosion, types of corrosion and its prevention by different methods. Introduction to electroplating.

6. Introduction to ores and minerals, extraction of metals from their ores, and purification. Eg., Manganese, Titanium and Uranium.
7. Study of alloys, classification, production and uses of alloys.

Course Outcomes Upon completion of the course students will be able to

1. Understand the concept of conductance in electrolytic solutions, electrolysis and redox reactions involved in electrode reactions.
2. Learn the different types of electrochemical cells, their symbolical representation and application of electrochemical series.
3. Apply conductometric, potentiometric and pH titrations
4. Know the principle, construction and working of batteries
5. Understand different types of corrosion and its prevention by different methods 6.Learn the methods of extraction of metals from their ores and purification

UNIT I

Electrochemistry

Conductance, specific and molar conductance, Types of electrolytes, conductivity in electrolytic solution, electrolysis, Kohlrausch's law and its application, equivalent conductance of weak electrolyte at Infinite dilution.

Oxidation -reduction reactions, electrode potential, EMF of an electrochemical cell, cell reaction, Daniel cell, dry Cells - electrolytic and Galvanic cell, Representation of a cell. Standard electrode potential, Nernst equation (No derivation) and its application to chemical cell, Electrochemical series and its importance. Types of Electrodes.

Basic Principles of (i) Conductometric titrations- HCl Vs NaOH, CH_3COOH Vs NaOH

(ii) Potentiometric titrations: Acid-base titration HCl Vs NaOH, Redox titration (FAS Vs $K_2Cr_2O_7$)

Determination of p^H using glass electrode.

12 hrs.

Batteries- Primary and secondary batteries, Battery components and their role. Working of the Lead acid and Lithium storage batteries, Fuel cells. **2hrs**.

UNIT II

Corrosion:

Introduction, definition, Types of corrosion, corrosion rate, factors affecting corrosion rate, Metallic factor-purity, electrode potential of metal, hydrogen over voltage, nature of corrosion product. Environmental factors-Temperature, pH of the medium, humidity, presence of impurities, electrical conductivity, velocity and concentration of the medium.

Prevention of Corrosion: Material selection - Metals and alloys, metal purification, non-metallic, Alteration of environment - Changing media, inhibitors, Design-wall thickness, design rules, Coating-Metallic and other inorganic coatings, organic coating.

Electroplating: Introduction, Electroplating of chromium (hard and decorative). Electroless plating: Introduction, distinction between electroplating and electrode plating processes. Electroless plating of copper.

14 hrs.

UNIT III

Metallurgy

Introduction: Ore, minerals, important ores of some common elements in India, General principles of pyrometallurgy, roasting, calcination, gangue, smelting, flux, gravity separation, froth flotation process, leaching. Techniques employed for purification of metal :Distillation process, Bessemerization, Electro-refining ,Van Arkel and De Boer's process.

6 hrs.

Extraction of metals: Extraction of Manganese (Pyrolusite), Titanium (Ilmanite) and Uranium.

4 hrs.

Alloys: Introduction, Classification of alloys, commercially important alloys, gold karats, Production of Ferro alloys- Ferrochrome, Ferromanganese, Uses of alloys.

-4 hrs.

Reference Books

1. Barrow. G.M, Physical chemistry, Tata McGraw-Hill, (2007)
2. An introduction to electrochemistry, Samuel Glasstone, East-West edition New Delhi, (1942)
3. Text book of physical chemistry, Samuel Glasstone, 2nd Edition, Mac Millan India Ltd, (1991)
4. Principles and applications of electrochemistry, D. R. Crow, 3rd edition, Chapmanhall London, (1988)
5. Fundamentals of electrochemical deposition, Milan Paunovic and Mordechay Schlesinger, Wiley Interscience Publications, New York, (1998)
6. Engineering Chemistry, V R Kulkarni and K Ramakrishna Reddy, New Age International, (2015)
7. Electrochemistry and corrosion Science, Nestor Perez, Springer (India) Pvt. Ltd., (2004)
8. Principles and prevention of corrosion, D. A. Jones, Macmillan Publ. Co., (1996)
9. Essential of materials science and engineering, Donald R. Askeland, Thomson Learning, 5th Edition, (2006)
10. Introduction to engineering materials, B. K. Agarwal, Tata McGraw Hill, 1st Edition (2013)
11. Material science and engineering, V. Raghavan, PHI Learning, 5th Edition (2004)
12. Engineering materials and metallurgy, R. K. Rajput, S. Chand - 1st Edition, (2011)

B.Sc III & IV SEMESTER MODEL QUESTION PAPER

CHEMISTRY

Time:2.5 h Max. marks :60

Note : all sections are compulsory

SECTION-A

1. Answer any FIVE of the following 5x2=10
   a.
   b.
   c.
   d.
   e.
   f.
   g.

SECTION-B

Answer any FOUR of the following4x5=20

2.
3.
4.
5.
6.
7.

SECTION-C

Answer any THREE of the following 3x10=30

8.
9.
10.
11.
12.

Note: Section C may include sub questions, a, and b

B.Sc III & IV SEMESTER MODEL QUESTION PAPER

CHEMISTRY OPEN ELECTIVE

Time:2.5 h Max. marks :60

Note : all sections are compulsory

SECTION-A

1. Answer any FIVE of the following 5x2=10
   a.
   b.
   c.
   d.
   e.
   f.
   g.

SECTION-B

Answer any FOUR of the following 4x5=20

2.
3.
4.
5.
6.
7.

SECTION-C

Answer any THREE of the following3x10=30

8.
9.
10.
11.
12.

Note: Section C may include sub questions, a, and b

INTERNAL ASSESMENT (as on 4th October meeting proceedings)

DISCIPLINE CORE	DISCIPLINE/OPEN ELECTIVE	PRACTICALS
60+40 (IA)	60+40 (IA)	25+25 (IA)
Class Test-20	Class Test-20	Continuous evaluation & class test-15
Seminars/Assignment-10	Seminars/Assignment-10	Record/Attendance- 5+5
Activity/Opendiscussion-10	Activity/Opendiscussion-10	