Minutes of meeting of Board of studies of Chemistry for BSc (Honors) Chemistry syllabus (Three Year) of CSJM University, Kanpur
Department of Chemistry
Date: 2nd June, 2025
Venue: Department of Chemistry **Mode**: online
Time: 2:00 PM – 5:00 PM

---

a) A meeting of Board of Studies was held in online mode on 2nd June 2025 at 2:00 pm.

b) The meeting was attended by the following members: -

1. Prof. Arti Saxena, Convener BoS Chemistry, Dean Faculty of Science, HoD Chemistry, A.N.D. College, Kanpur.
2. Dr. Dhananjay Dey, Coordinator BoS Chemistry for B.Sc. (Hons) Chemistry , Coordinator/HoD Chemistry, School of Basic Science, C.S.J.M. University, Kanpur

External Members-

3. Prof. C.L. Gehlot, Dept. of Chemistry, H.B.T.U. Kanpur
4. Prof. U.N. Tripathi, Dept. of Chemistry, D.D.U. Gorakhpur
5. Prof. R.N. Singh, Dept. of Chemistry, Lucknow University, Lucknow
6. Prof. S.S.S. Kushwaha, Ex – Principal, Dept. of Chemistry, P.P.N. College, Kanpur

Internal Members-

7. Dr. Sanjay Asthana, Dept. of Chemistry, D.A-V. College, Kanpur
8. Prof. Jai Veer Singh, Dept. of Chemistry, Nehru P.G. College, Chhibramau, Kannauj
9. Prof. Om Kumari, Dept. of Chemistry, K.K. P.G. College, Etawah

c) This syllabus of BSc (Honors) Chemistry syllabus (Three Year) was unanimously passed through the Board, following all the norms of UGC guidelines, with Modification of previous syllabus (2021-2022), NEP-2020.

Agenda:

1. Review of the existing B.Sc. (Hons) Chemistry Syllabus (2021–2022)
2. Proposed modifications in theory and practical papers across three years
3. Major modifications in practical structure
4. Addition and reclassification of theory and elective courses
5. Introduction of skill-based and interdisciplinary courses
6. Finalization of the revised syllabus for implementation from academic session 2025–2026

Poceedings:

Opening Remarks:

- The meeting began with a welcome address by Prof. Arti Saxena, Convener BoS Chemistry, who highlighted the need for upgrading the syllabus in accordance with academic advancements and research needs.
- Dr. D. Dey, Coordinator for the B.Sc. (Honors) Chemistry syllabus revision, addressed the members of the Board of Studies and played a key role in leading the academic discussion.

Item 1: Major Modifications in Practical Component

- A significant revision was proposed and approved in the practical structure:
- Only one practical course will be conducted per semester to enhance depth and quality of laboratory training.
- Practical syllabi will emphasize hands-on skills, instrumental techniques, data interpretation, and eco-friendly experiments.
- This change aims to reduce redundancy, improve time management, and allow deeper student engagement in laboratory work.

Item 2: Theory and Elective Course Restructuring

(1) Addition of New Theory Courses:

- The following theory courses were introduced to enrich the academic rigor:
- Inorganic Chemistry- V
- Nano Chemistry

(2) Rationalization of Electives:

- A large number of elective courses from the previous syllabus have been removed to ensure better focus and uniformity.
- A specific and limited number of elective courses have been retained and revised for relevance and coherence.

(3) Reclassification of Electives as Major Courses:

- Some previously listed elective courses have been upgraded to core (major) courses due to their foundational or advanced significance:
- Polymer Chemistry
- Analytical Methods in Chemistry

Item 3: Approval & Implementation

- The Board of Studies unanimously approved the revised syllabus, incorporating the above changes.
- The new structure will be implemented from the academic session 2025–2026.

Resolution Passed:

"The Board of Studies, Department of Chemistry, CSJM University, Kanpur, hereby approves the revised B.Sc. (Honors) Chemistry syllabus (Three-Year Program) with one practical per

semester, revised theory course offerings, a rationalized set of electives, and NEP-aligned structure for implementation from the session 2025–2026.”

Conclusion:
The meeting ended with a vote of thanks to the Convenor and the members for their valuable insights and cooperation in finalizing the B.Sc. (Hons) Chemistry syllabus.

Signatures:

Prof. Arti Saxena **Convener, BoS Chemistry** **Dean, Faculty of Science**	**Dr. Dhananjay Dey** **Coordinator, BoS chemistry** **C.S.J.M. University, Kanpur**	**Prof. C.L. Gehlot** **H.B.T.U. Kanpur**
Prof. U.N. Tripathi **D.D.U. Gorakhpur, Gorakhpur**	**Prof. R.N. Singh** **Lucknow University, Lucknow**	**Prof. S.S.S. Kushwaha** **Ex – Principal, P.P.N. College, Kanpur**
Dr. Sanjay Asthana **D.A-V. College, Kanpur**	**Prof. Jai Veer Singh** **Nehru P.G. College, Chhibramau, Kannauj**	**Prof. Om Kumari** **K.K. P.G. College, Etawah**

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

CURRICULUM AND CREDIT FRAMEWORK FOR B.Sc. HONOURS CHEMISTRY (3YEARS)

Semester I			
COURSE CODE	**TYPE**	**COURSE TITLE**	**CREDITS**
BH020101T	CORE	Inorganic Chemistry I	4
BH020102T	CORE	Physical Chemistry I	4
BH020103P	CORE	Lab Course I- Organic Chemistry	4
VOCxxx	Skill enhancement course	Vocational Skill Enhancement course I	3
Z011101	Co-curricular Course	First Aid and Basic Health	2
	TOTAL		17

Semester II			
BH020201T	CORE	Organic Chemistry-I	4
BH020202T	CORE	Physical Chemistry-II	4
BH020203P	CORE	Lab Course II - Inorganic Chemistry	4
BH020204TM	Minor Course	Fundamentals of Chemistry-I (For other departments)	6
VOCxxx	Skill enhancement course	Vocational Skill Enhancement course I	3
Z021201	Co-curricular Course	Human Values and Environment Studies	2
	TOTAL		23
	Total credits after completion of 1 year		40

NOTE: 1. Total credits after completion of 1 year=40
2. Student is entitled for certificate in Faculty after successful completion of first two semesters.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester III

BH020301T	CORE	Inorganic Chemistry- II	4
BH020302T	CORE	Organic Chemistry- II	4
BH020303P	CORE	Lab Course III -Physical Chemistry	4
VOCxxx	Skill Enhancement course (SEC)	Vocational Skill Enhancement course	3
Z031301	Co-curricular Course	Physical Education and Yoga	2
	TOTAL		17

Semester IV

BH020401T	CORE	Inorganic Chemistry-III	4
BH020402T	CORE	Physical Chemistry-III	4
BH020403P	CORE	Lab Course IV- Analytical Chemistry	4
BH020405TM	Minor Course	Fundamentals of Chemistry-II (For other departments)	6
BH020404R	Project	Research Project/Internship/Field Work	3
Z041401/ Z041402	Co-curricular Course	Social Responsibility and Community Engagement/Indian Language	2
	TOTAL		23
	Total credits after completion of 2nd year		40+40=80

NOTE: 3. Total credits after completion of 2nd year=80

4. Student is entitled for Diploma in Faculty after successful completion of four semesters.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester V

BH020501T	CORE	Inorganic Chemistry IV	4
BH020502T	CORE	Organic Chemistry-III	4
BH020503T/ BH020507ET/	CORE/ Elective 1	Physical ChemistryIV/ Elective papers (Research Methodology for Chemistry)	4
BH020504T/ BH020508ET/	CORE/ Elective 2	Polymer Chemistry/ Elective Papers (Nano Chemistry)	4
BH020505P	Practical - V	Lab Course V-Advance Inorganic and Organic Chemistry Lab	4
BH020506R	Research Project	Research Project on topics which are Inter/Intra faculty	5
	TOTAL		25

Semester VI

BH020601T	CORE	Inorganic Chemistry- V	4
BH020602T	CORE	Physical Chemistry-V	4
BH020603T/ BH020607ET/	CORE/ Elective 3	Organic Chemistry-IV/Elective papers (Green Chemistry)	4
BH020604T/ BH020608ET/	CORE/ Elective 4	Analytical Methods in Chemistry/ Elective papers (Inorganic Materials of Industrial Importance)	4
BH020605P	Practical - V	Lab Course VI-Advance Physical Chemistry and Polymer Chemistry Lab	4
BH020606R	Research Project	Research Project on topics which are Inter/Intra faculty	5
	TOTAL		25
GRAND TOTAL			**130**

NOTE: 5. Total credits after completion of 3rd year=130

6. The student is entitled to a 3-year B.Sc.(Honours) Chemistry UG degree after successful completion of six semesters.

Elective Papers: (Credit 04 each)

1) **Research Methodology for Chemistry (4)**
2) **Nano Chemistry(4)**
3) **Green Chemistry (4)**
4) **Inorganic Materials of Industrial Importance (4)**

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

NOTE:

1. **Do not mark any code or information in Column A, as it will be endorsed by the University.**
2. Column B defines the nature of the course/paper. The word **CORE** herein stands for **Compulsory Subject Paper**.
3. Column D depicts the credits assigned for the corresponding course/paper.
4. **Elective:** It will be a Subject Elective.
5. Research project can be done in the form of an Internship/Survey/Field work/Research project/ Industrial training, for which a report/dissertation shall have to be submitted. The evaluation for the same shall be done at the end of each year in form of seminar/presentation and viva voce.
6. The student straight away will be awarded 05 credits if he publishes a research paper on the topic of the Research Project or Dissertation.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester I

Course Code- BH020101T
Course Name- Inorganic Chemistry I **(Credits: 04)**

Unit I-Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wavefunctions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams.Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and itslimitations, Variation of orbital energy with atomic number.

Unit II- Periodicity of Elements:

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the followingproperties of the elements, with reference to *s* & *p*-block.

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(a) Atomic radii (van der Waals)
(b) Ionic and crystal radii.
(c) Covalent radii (octahedral and tetrahedral)
(d) Ionisation enthalpy, Successive ionization enthalpies and factors affecting ionizationenergy. Applications of ionization enthalpy.
(e) Electron gain enthalpy, trends of electron gain enthalpy.
(f) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

Unit III- Chemical Bonding:

(i)Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Structure of Nacl, ZnS, SiO_2, CaF_2, AlF_3, Na_2O. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.
(ii) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital

interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containinglone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules andconsequences of polarization.Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

(i)Metallic Bond: Qualitative idea of valence bond and band theories. emiconductors and insulators, defects in solids.

(ii) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility, energetics of dissolution process.

Unit IV - Oxidation-Reduction:

Redox equations, Standard Electrode Potential and its application to inorganic reactions.Principles involved in volumetric analysis to be carried out in class.

Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Shriver & Atkins inorganic chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
- Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry,*

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020102T
Course Name- Physical Chemistry I **(Credits: 04)**

Unit I- Gaseous state:

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.Maxwell distribution and its use in evaluating molecular velocities (average, root meansquare and most probable) and average kinetic energy, law of equipartition of energy, degreesof freedom and molecular basis of heat capacities.Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Unit II- Liquid state:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.Qualitative discussion of structure of water.

Unit III- Solid state:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

Unit IV-Ionic equilibria:

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases,pH scale, common ion effect; dissociation constants of mono-

, di-and triprotic acids (exact treatment).Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.

Solubility and solubility product of sparingly soluble salts – applications of solubility productprinciple. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.ultistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

Reference Books:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code-BH020103P
Course Name - Lab Course I- Organic Chemistry **(Credit : 4)**

Unit 1: Physical and Chemical Properties

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. Determination of the melting points of the above compounds and unknown organiccompounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organiccompounds

Unit 2: Qualitative Analysis

Functional group tests for alcohols, phenols, amines, nitro, carbonyl and carboxylic acid, ester groups.

Unit 3: Preparation of Organic Compounds

Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*- p-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylicacid) by any one method:
Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine)

a. Synthesis of p-nitroacetanilide from acetanilide

b. Synthesis of p-aminoazo benzene from aniline.

c. Synthesis of p–bromoaniline.

Reference Books:

1) A.R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*, 5th Ed., John Willey (1996).
2) H. Middleton , *Systematic Qualitative Organic Analysis*, Adward Arnold (1939).
3) H. Clark, *Handbook of Organic Analysis*, Adward Arnold (1946)
4) Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education(2009)
5) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.,* Pearson (2012)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

VOCxxx- Vocational Skill Enhancement course I

Z011101-First Aid and Basic Health

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester II

Course Code- BH020201T

Course Name -Organic Chemistry-I (Credits: 04)

Unit I- Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.*Electronic isplacements:* Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; theirrelative strength.Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit II-Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules.*Optical Isomerism:* Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

Unit III- Chemistry of Aliphatic Hydrocarbons

A. Carbon-Carbon sigma bonds

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

B. Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. N *Reactions of alkenes:* Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.*Reactions of alkynes:* Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

C. Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unit IV-Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry ofNatural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London,1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International,2005.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code-BH020202T

Course Name -Physical Chemistry-II **(Credits: 04)**

Unit I- Chemical Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems;zeroth law of thermodynamics. *First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law;enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy.Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absoluteentropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit II- Systems of Variable Composition:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs- Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions inmixing of ideal gases.

Unit III- Chemical Equilibrium:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit IV- Solutions and Colligative Properties:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and theirapplications. Excess thermodynamic functions.Thermodynamic derivation using chemical potential to derive relations between the fourcolligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point,(iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applicationsin calculating molar masses of normal, dissociated and associated solutes in solution.

Reference Books

- Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.:New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code-BH020203P **(Credit:4)**

Course Name- Lab Course II- Inorganic Chemistry

1) Qualitative analysis of inorganic mixture salts containing 4/5-radicals including interfering radicals.

   a) Qualitative analysis of acid radicals
   b) Qualitative analysis of basic radicals
   c) Qualitative analysis of interfering radicals.

   The following radicals are suggested:

   CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+,Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

2) Preparation of inorganic and coordination compounds and their characterization
   a) Hexaaminenickel(II)chloride
   b) Tetraamminecopper(II)sulphate monohydrate.
   c) Cis & Trans-$K[Cr(C_2O_4)_2(H2O)_2]$
   d) Tris (thiourea) copper(I) complex
   e) Co(Salen) complex

Reference Books

1) A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis*, 3rd Ed., Longmans (1961).
2) M. Kolthoff, P. J. Elving and E. B. Sandell, *Treatise on Analytical Chemistry*, Pt-I, II, III, The Interscience Encyclopedia, Inc., New York (1959).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code: BH020204TM

Course Name: Fundamentals of Chemistry-I (Credits: 04)

***Unit I- Section A:* Organic chemistry:**

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonanceand Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Unit II: Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Unit III- Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). *Preparation:* Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) *Preparation:* Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) *Preparation:* Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Unit IV- Section B: Inorganic Chemistry

Atomic Structure: Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number (*s*) and magnetic spin quantum number (m_s).Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stabilityof half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods.(including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO.

Reference Books:

- J. D. Lee: *A new Concise Inorganic Chemistry*, E L. B. S.
- F. A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry*, John Wiley.

- Douglas, McDaniel and Alexader: *Concepts and Models in Inorganic Chemistry*,John Wiley.
- James E. Huheey, *Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principlesof Structure and Reactivity*, Pearson Publication.
- T. W. Graham Solomon: *Organic Chemistry, John Wiley and Sons*.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

VOCxxx- Vocational Skill Enhancement course I

Z021201-Human Values and Environment Studies

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester III

Course Code- BH020301T

Course Name - Inorganic Chemistry- II **(Credits: 04)**

Unit I- General Principles of Metallurgy

The chief modes of occurrence of metals are based on standard electrode potentials. Ellingham diagrams for the reduction of metal oxides using carbon and carbon monoxide as reducing agents. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, and Zone refining.

Unit II- Acids and Bases

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, back strain(B-strain) and front strain (F-strain), Super acid, Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.

Unit III- Chemistry of *s* and *p* Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of the first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.Hydrides and their classification: ionic, covalent and interstitial. Basic beryllium acetate and nitrate. study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Unit IV- Noble Gases:

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Unit V- Inorganic Polymers:

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspectsand applications of silicones and siloxanes. Borazines, boron nitride, silicates and phosphazenes, and polysulphates.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models ofInorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
- Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020302T

Course Name - Organic Chemistry- II **(Credits: 04)**

Unit I-Chemistry of Halogenated Hydrocarbons:

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.*Aryl halides:* Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism.Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Unit II- Alcohols, Phenols, Ethers and Epoxides:

Alcohols: preparation, properties and relative reactivity of 1˚, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Unit III- Carbonyl Compounds:

Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammoniaderivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisan-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, NaBH4, MPV, PDC and PGC);Addition reactions of unsaturated carbonyl compounds: Michael addition.Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Unit IV- Carboxylic Acids and their Derivatives:

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric

acids;Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group - Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.

Unit V- Sulphur containing compounds:

Preparation and reactions of thiols, thioethers and sulphonic acids.

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020303P

Course Name- Lab Course III- Physical Chemistry (Credit-4)

List of experiments:

Unit I- Surface tension and viscosity measurements

1. Determination of viscosity of given solutions of at room temperature using Ostwald's viscometer.
2. Determine the surface tension of given liquid.

Unit II - Thermochemistry

3. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
4. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

Unit III- Phase equlibrium and Distribution coefficients

5. Determination of critical solution temperature and composition of the phenol-watersystem and to study the effect of impurities on it.
6. To determine the distribution coefficient of acetic acid between n-butanol and water.

Unit IV- Chemical kinetics

7. To study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid and calculate the order of reaction.
8. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.

Unit V- Coductometric Titration

9. To determine the strength of a given hydrochloric acid solution conductometrically by titrating it against a standard solution of sodium hydroxide (Strong acid vs. strong base).

10. To determine the strength of a given acetic acid solution conductometrically by titrating it against a standard solution of sodium hydroxide (Weak acid vs. strong base).
11. To determine the strength of a given weak base solution conductometrically by titrating it against a standard solution of strong acid (Strong acid vs. weak base).

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R.Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

VOCxxx- Vocational Skill Enhancement course

Z031301-

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester IV

Course Code- BH020401

Course Name - Inorganic Chemistry-III **(Credits: 04)**

Unit I- Coordination Chemistry:

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

Unit II- Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series.Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

Unit III- Lanthanoids and Actinoids:

Electronic configuration, oxidation states, colour, spectral and magnetic properties,lanthanide contraction, separation of lanthanides (ion-exchange method only).

Unit IV- Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their actionin biological system. Geochemical effect on the distribution of metals. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron, hemocyanin, Cu-Zn SOD, Nitrogenase activity.

Reference Books:

- Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
- Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima PublishingCompany 1994.
- Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley &Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., Chemistry of the Elements, Butterworth-Heinemann,1997.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code -BH020402T

Course Name - Physical Chemistry-III **(Credits:04)**

Unit I-Phase Equilibria:

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications.Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions.Three component systems, water-chloroform-acetic acid system, triangular plots.*Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation.Nernst distribution law: its derivation and applications.

Unit II- Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimentalmethods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit III-Catalysis:

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit IV-Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state.

Reference Books:

- Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press(2010).

- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.:New Delhi (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.*Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Zundhal, S.S*. Chemistry concepts and applications* Cengage India (2011).
- Ball, D. W. *Physical Chemistry* Cengage India (2012).
- Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
- Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill (2011).
- Metz, C. R*. Physical Chemistry 2nd Ed.,* Tata McGraw-Hill (2009).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020403P

Course Name - lab Course IV-Analytical Chemistry (Credits: 04)

List of Experiments:

Unit I: Chromatography

1. Principles involved in chromatographic separations. Paper chromatographic separation of the following metal ions:

i. Ni (II) and Co (II)

ii. Fe (III) and Al (III)

2. Separation of a mixture of amino acids using the Paper chromatography method.
3. Separation of a mixture of amino acid using Thin Layer chromatography method.
4. Extraction of organic species using solvent extraction and determine the concentration of extracted organic species.

Unit II- UV- Visible Spectroscopy

5. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
6. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
7. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.
8. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/ $KMnO_4$/ $K_2Cr_2O_7$ in a solution of unknown concentration

Unit III- pH metry Titration

9. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid,sodium acetate and their mixtures.
10. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

Unit IV:

11. Determination of chemical oxygen demand (COD).
12. Determination of Biological oxygen demand (BOD).
13. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.

14. Separation of amino acids from organic acids by ion exchange chromatography.

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H.Jeffery and others) 5th Ed. The English Language Book Society of Longman .
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. WardsworthPublishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York,2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, InternationalPublisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis,Thomson Asia Pvt. Ltd. Singapore.
- Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & AlliedMethods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code: BH020405TM

Course Name: Fundamentals of Chemistry-II **(Credits : 04)**

Unit I: Solutions

Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature- composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partialmiscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction.

Unit II- Conductance

Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.

Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degreeof ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid- base).

Unit III-Electrochemistry

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transferenceand without transference. 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 IV- Section B: Organic Chemistry

Carboxylic acids and their derivatives

Carboxylic acids (aliphatic and aromatic) *Preparation:* Acidic and Alkaline hydrolysis of esters.*Reactions:* Hell – Vohlard - Zelinsky Reaction.

Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion. *Reactions:* Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation.

Amines and Diazonium Salts

Amines (Aliphatic and Aromatic): (Upto 5 carbons)

Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction.

Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.

Diazonium salts: *Preparation:* from aromatic amines.

Reactions: conversion to benzene, phenol, dyes.

Amino Acids, Peptides and Proteins:

Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis.

Reactions of Amino acids: ester of –COOH group, acetylation of $-NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins Determination of Primary structure of Peptides by degradation Edmann degradation (N- terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C- activating groups and Merrifield solid-phase synthesis.

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

Reference Books:

- G. M. Barrow: *Physical Chemistry* Tata McGraw-Hill (2007).
- G. W. Castellan: *Physical Chemistry* 4th Ed. Narosa (2004).
- J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage LearningIndia Pvt. Ltd.: New Delhi (2009).
- B. H. Mahan: *University Chemistry*, 3rd Edn. Narosa (1998).

- R. H. Petrucci, *General Chemistry*, 5th Edn., Macmillan Publishing Co.: New York(1985).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H.Freeman.
- Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman

BH020404R- Research Project/Internship/Field Work

Z041401/Z041402- Social Responsibility and Community Engagement/Indian Language

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester V

Course Code-BH020501T

Course Name -Inorganic Chemistry IV **(Credits:04)**

Unit I- Theoretical Principles in Qualitative Analysis (H_2S Scheme)

Basic principles involved in the analysis of cations and anions, and solubility products, the common ion effect. Principles involved in the separation of cations into groups and the choice of group reagents. Interfering anions (fluoride, borate, oxalate, and phosphate) need to be removed after Group II.

Unit II- Organometallic Compounds

Definition, History, and classification of organometallic compounds based on bond type. Concept of hapticity of organic ligands. Zeise's salt: Preparation and structure, evidence of synergic effect, and comparison of synergic effect with that in carbonyls. Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler–Natta Catalyst). Species present in the ether solution of Grignard reagent and their structures, Schlenk equilibrium. Metal Carbene, Fischer and schrock carbene, Ferrocene:Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Metal carbonyls and nitrosyls: 18-electron rule, effective atomic number(EAN-rule), electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. Acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect, and use of IR data to explain extent of back bonding, Vaska's complex. Definition, classification, bonding, preparation and properties of metal nitrosyls,

Unit III- Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect,

Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Unit IV- Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

Reference Books:

Recommended Texts:

- Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall,1996-03-07.
- Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.
- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry3rd Ed.,* John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements, Elsevier 2nd Ed*,1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. *Concise Inorganic Chemistry 5th Ed.,* John Wiley and sons 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press,1994.
- Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of MetalComplexes in Solution 2nd Ed.,* John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
- Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4th Ed.,* Pearson, 2010.

- Collman, James P. et al. *Principles and Applications of Organotransition MetalChemistry*. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals. j*

  New York, NY: John Wiley, 2000.
- Spessard, Gary O., &Gary L. Miessler. *Organometallic Chemistry*. Upper SaddleRiver, NJ: Prentice-Hall, 1996.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020502T

Course name -Organic Chemistry-III **(Credits:-04)**

Unit I- Nitrogen Containing Functional Groups

Preparation and important reactions of nitro and compounds, nitriles and isonitriles

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

Diazonium Salts: Preparation and their synthetic applications.

Unit II- Polynuclear Hydrocarbons

Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

Unit III-Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis),Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and furoic acid.

Unit IV- Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action, Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation andsynthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Unit V- Terpenes

Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral,Neral and α-terpineol.

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry ofNatural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* JohnWelly & Sons (1976).
- Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
- Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P)Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* OxfordUniversity Press.
- Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan(2010).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020503T/ BH020507ET

Course Name - Physical Chemistry IV
(Credits: 04)

Unit I- Conductance

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivityand their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, 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, and (v) hydrolysis constants of salts.

Unit II- Electrochemistry

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pHvalues, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes.Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Unit III- Electrical & Magnetic Properties of Atoms and Molecules

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement, molecular interpretation.

Reference Books:

- Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press(2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP (2009).
- Barrow, G. M., *Physical Chemistry 5th Ed.,* Tata McGraw Hill: New Delhi (2006).

- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
- Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.,* JohnWiley & Sons, Inc. (2005).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020507ET

Course Name - Research Methodology for Chemistry (Credits: 04)

Unit I- Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

Unit II- Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.

Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work.Writing ethics. Avoiding plagiarism.

Unit III-Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of

laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Unit IV-Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use.Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

Unit V-Electronics

Basic fundamentals of electronic circuits and their components used in circuits of common instruments like spectrophotometers, typical circuits involving operational amplifiers for electrochemical instruments. Elementary aspects of digital electronics.

Reference Books

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. OxfordUniversity Press.
- Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., ChapmanHall, London.
- Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific dataanalysis.* Cambridge Univ. Press (2001) 487 pages.
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.
- OSU safety manual 1.01.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020504T

Course Name - Polymer Chemistry **(Credits: 04)**

Unit I- Introduction and Basics of Polymers:

Classification of polymers, nomenclature, Molecular forces andchemical bonding in polymers, Functionality, degree of polymerization. Bi- functional systems, Poly-functional systems, Addition and Condensation polymerisation, Concept of Molecular weight of a polymer (M_n, M_w, etc)), determination of molecular weight by viscometry, light scattering and osmotic pressure methods. Polydispersity index.

Unit II- Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and polymerization techniques.

Unit III- Structure and Properties of Polymers

Crystallization and crystallinity: Crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Glass transition temperature (T_g) and determination of T_g, Free volume theory, , Factors affecting glass transition temperature (Tg).structure Property relationships.

Unit IV - Commercially important Polymers

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene poly(vinyl chloride) poly(vinyl acetate) , acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, Ntural and synthetic rubbers, Polycarbonates, Conducting Polymers: [polyacetylene, polyaniline, polypyrrole, polythiophene)].

Reference Books:

- *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
- G. Odian: Principles of Polymerization, John Wiley.
- F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
- P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
- R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020504ET

Course Name - Nano Chemistry (Credits: 04)

UnitI: Introduction

Definitions and course organization, Historical development of nanomaterials , Classification of nanomaterials.

Unit-II: Preparation

Top down and bottom up approach, electrochemical, chemical, photochemical and biochemical synthesis of nano particles.

Unit-III: Structure and Bonding

Chemical Bonds (types and strength) Intermolecular forces, Molecular and Crystalline structures, Hierarchical structures, Bulk to surface transition, surface reconstruction, self assembly and thermodynamics

Unit-IV: Properties & Characterization

Size dependence of properties Chemical Optical, vibrational, thermal, electrical, magnetic ,mechanical, theoretical Aspects-e.g. density functional theory, Scanning and Transmission Electron Microscopy, Scanning Probe Microscopies: Atomic Force, scanning tunneling microscopy Diffraction and scattering techniques, Vibrational spectroscopy, Surface techniques

Unit-V: Advanced Applications

Nano-electronics, Nano optics, Nanoscale chemical- and bio-sensing, Biological/bio-medical applications, Photovoltaic, fuel cells, batteries and energy-related applications, High strength nanocomposites , Nanoenergetic materials.

Books Recommended

Reference Books:

1. T. Pradeep, *NANO: The Essentials,* Tata-McGraw Hill, New Delhi, 2007.
2. D. W. Bruce and D. O'Hare, *Inorganic Materials,* John Wiley and Sons, New York, 1992.
3. C. M. Sorensen, *Magnetism in Nanoscale Materials in Chemistry*, Wiley Interscience, New York,2001.
4. K.J. Klabunde, *Nanoscale Materials in Chemistry*, Wiley-interscience, 2001
5. Bharat Bhushan (Ed.) *Springer Handbook of Nanotechnology,* Springer, 2007
6. C.P. Poole, and F.J. Owens, *Introduction to Nanotechnology*, Wiley India, 2006
7. G.A. Ozin, C. Andre, and L. Arsenault, Cademartiri, *Nanochemistry: A chemical Approach to Nanomaterials,* Royal Society of Chemistry, 2005
8. K. J. Klabunde, *Free Atoms, Clusters and Nanoscale Particles*, Academic Press, New York, 1994.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020505P

Course Name - lab Course V- Advance Inorganic and Organic Chemistry Lab (Credits: 04)

1) **Gravimetric Analysis:**
   A. Estimation of nickel (II) using Dimethylglyoxime (DMG).
   B. Estimation of copper as CuSCN
   C. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$.
   D. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).
2) **Iodo / Iodimetric Titrations**
   a. Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution(Iodimetrically).
   b. Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
   c. Estimation of available chlorine in bleaching powder iodometrically.
3) **Complexometric Titration:**
   a) Determination of total hardness of water.
4) **Preparation of inorganic complexes and find the λ_{max}**
   b) Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of the complex.
   c) Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.
5) **Preparation of Organic Compound**

1. Synthesis of Dibenzal acetone from benzaldehyde (Aldol condensation).
2. Synthesis of anthranilic acid from phthalic anhydride.
3. Synthesis of ethyl n-butylacetoacetate by acetoacetic ester condensation.
4. Cannizaro reactions: 4-chlorobenzaldehyde as substrate.

6) **Extraction:**

1. Isolation of caffeine from tea leaves.
2. Isolation of lycopene from tomato.
3. Isolation and characterization of DNA from onion/ cauliflower/peas.

BH020506R- Research Project on topics which are Inter/Intra faculty

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Semester VI

Course Code -BH020601T

Course Name - Inorganic Chemistry- V **(Credit : 04)**

Unit 1- Metal Ligand Equilibrium

Equilibria Stability of mononuclear, polynuclear mixed ligand complexes in solution, Stepwise and overall formation constants, trends in stepwise constants factors affecting the stability of metal complexes – chelate effect, determination of stability constants.

Unit 2- Metal ligand bonding & electronic spectra

d-d transitions,charge transfer spectra, laporte selection rule, vibronic coupling. spin-orbit coupling(R-S coupling), term symbol, quenching of orbital contribution, Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1 –d^9 states), calculations of Dq, B and β parameters, charge transfer spectra

Unit 3- Organometallic Chemistry

Historical development, classification, nomenclature, valence electron count, oxidation number, and formal ligand charge. Synthesis, structure and bonding of alkyls, alkenes, allyl, alkynes, and arenes. Delta bond, calculation of M-M bond, isolobal analogy. Classification, synthesis, reaction, structure and bonding in Boranes, Nitrogens and Phosphorous compounds.

Unit 4- Magneto Chemistry

Van Vleck equation and its application, Curie's law and curie Weiss law, hysteresis loop,zero field splitting, orbital quenching, paramagnetism, diamagnetism, ferromagnetis, ferrimagnetism and anti-ferromagnetic coupling.

Reference Books:

- Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall,1996-03-07.
- Cotton, F.A. G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.

- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry3rd Ed.,* John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements, Elsevier 2nd Ed*,1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. *Concise Inorganic Chemistry 5th Ed.,* John Wiley and sons 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press,1994.
- Basolo, F. & Person, R. *Mechanisms of Inorganic Reactions: Study of MetalComplexes in Solution 2nd Ed.,* John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
- Miessler, G. L. & Donald, A. Tarr, *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
- Collman, James P. et al. *Principles and Applications of Organotransition MetalChemistry*. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals. j*

  New York, NY: John Wiley, 2000.
- Spessard, Gary O., &Gary L. Miessler. *Organometallic Chemistry*. Upper SaddleRiver, NJ: Prentice-Hall, 1996.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code -BH020602T

Course Name -Physical Chemistry-V **(Credits: 04)**

Unit I- Quantum Chemistry

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting upof Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion ofsolution.Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.Setting up of Schrödinger equation for many-electron atoms (He, Li). Need forapproximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Unit II- Molecular Spectroscopy:

Interaction of electromagnetic radiation with molecules and various types of spectra; Born- Oppenheimer approximation.Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies.

Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclearspin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules.Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR ofsimple radicals.

Unit III- Photochemistry

Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry,examples of low and high quantum yields, photochemical equilibrium and the differentialrate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

Reference Books:

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. TataMcGraw-Hill: New Delhi (2006).
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
- House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020603T/ BH020607ET

Course Name - Organic Chemistry-IV **(Credits: 04)**

Unit I- Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;, Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine;Structure of polynucleotides.

Unit II- Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification.α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values,isoelectric point and electrophoresis;Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis

Unit III- Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes.Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Unit IV-Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion offats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Unit V- Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules).Introduction to metabolism (catabolism, anabolism).ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change.Agents for transfer of electrons in biological redox systems: NAD^+, FAD.Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis,fermentation, Krebs cycle.Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate.Caloric value of food, standard caloric content of food types.

Unit VI- Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of

chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Reference Books:

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H.Freeman and Co.
- Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IVEdition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020604T

Course Name – Green chemistry **(Credits: 04)**

UNIT-I:Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

UNIT-II:Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energyrequirements for reactions - use of microwaves, ultrasonic energy; selection of startingmaterials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

UNIT-III:Examples of Green Synthesis/ Reactions

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.

2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols).Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation.Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation

of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2- dihydrotriazine derivatives; benzimidazoles.

3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions,Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

4. Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

UNIT-IV: Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

Reference Books:

- V.K. Ahluwalia & M.R. Kidwai: New Trends in Green Chemistry,
- Anamalaya Publishers (2005).
- P.T. Anastas & J.K. Warner: Oxford Green Chemistry-Theory and Practical,University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
- M.C. Cann & M.E. Connely: Real-World cases in Green Chemistry, AmericanChemical Society, Washington (2000).
- M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American ChemicalSociety, Washington (2002).

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020604T

Course Name - Analytical Methods in Chemistry (Credits: 04)

Unit I- Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, and normal law of distribution.

Unit II-Optical methods of analysis:

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy, and selection rules, validity of Beer-Lambert's law.

Basic principles, instrumentation, and applications of UV-Visible Spectrometry, IR Spectrometry, and Atomic Absorption Spectrometry(AAS)

Unit III- Thermal and Electroanalytical Methods of Analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values.

Unit V- Separation techniques:

Solvent extraction, Mechanism of extraction: extraction by solvation and chelation. Techniques of extraction: batch, and continuous extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange.Development of chromatograms, Paper Chromatography, Thin alasyer Chromatography

Reference Books:

- Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H.Jeffery and others) 5th Ed. The English Language Book Society of Longman .
- Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. WardsworthPublishing Company, Belmont, California, USA, 1988.
- Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York,2004.
- Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.

- Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, InternationalPublisher, 2009.
- Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis,Thomson Asia Pvt. Ltd. Singapore.
- Mikes, O. & Chalmes, R.A. Laboratory Hand Book of Chromatographic & AlliedMethods, Elles Harwood Ltd. London.
- Ditts, R.V. Analytical Chemistry – Methods of separation.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code- BH020608ET

Course Name – Inorganic Materials of Industrial Importance (Credits: 04)

Unit-I: Silicate Industries

Glass: Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following types of glasses: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate, coloured glass, photosensitive glass.

Ceramics: Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications, superconducting and semiconducting oxides,fullerenes carbon nanotubes and carbon fibre.

Cements: Classification of cement, ingredients and their role, Manufacture of cement and the setting process, quick setting cements.

Unit-II: Fertilizers:

Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammoniumnitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

Unit-III: Surface Coatings:

Objectives of coatings surfaces, preliminary treatment of surface, classification of surface coatings. Paints and pigments-formulation, composition and related properties. Oil paint, Vehicle, modified oils, Pigments, toners and lakes pigments, Fillers, Thinners, Enamels, emulsifying agents. Special paints (Heat retardant, Fire retardant, Eco-friendly paint, Plastic paint), Dyes, Wax polishing, Water and Oil paints, additives, Metallic coatings (electrolytic and electroless), metal spraying and anodizing.

Unit-IV: Batteries:

Primary and secondary batteries, battery components and their role, Characteristics of Battery. Working of following batteries:

Pb acid, Li-Battery, Solid state electrolyte battery. Fuel cells, Solar cell and polymer cell.

Unit-V: Alloys:

Classification of alloys, ferrous and non-ferrous alloys, Specific properties of elements in alloys. Manufacture of Steel (removal of silicon decarbonization, demanganization, desulphurization dephosphorisation) and surface treatment (argon treatment, heat treatment, nitriding, carburizing). Composition and properties of different types of steels.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R. M. Felder, R. W. Rousseau: *Elementary Principles of Chemical Processes*, WileyPublishers, New Delhi.
- W. D. Kingery, H. K. Bowen, D. R. Uhlmann: *Introduction to Ceramics,* WileyPublishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- P. C. Jain, M. Jain: *Engineering Chemistry,* Dhanpat Rai & Sons, Delhi.
- R. Gopalan, D. Venkappayya, S. Nagarajan: *Engineering Chemistry,* VikasPublications, New Delhi.
- B. K. Sharma: *Engineering Chemistry*, Goel Publishing House, Meerut

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: B.Sc.(Hons.) SUBJECT: Chemistry

Course Code - BH020605P

Course name- Lab Course VI- Advance Physical Chemistry and Polymer Chemistry Lab

(Credit :4)

List of Experiments:

1. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methylacetate.
2. Determine the solubility of benzoic acid in water and determine the enthalpy change for dissolution process.
3. To study the effect of addition of an electrolyte on the solubility of an organic acid.
4. To study the adsorption of oxalic acid from aquweous solution by any adsobant(like active charcoal) and verify frenuldlich and LAngmuire adsorption isotherms.
5. To study the adsorption of iodine from aqueous potassium iodide solution by active charcoal) and verify Frenuldlich and Langmuire adsorption isotherms.
6. Determine the molecular weight of non volatile substance(Polymer) by cryoscopic method.
7. Determination of molecular weight of an addition polymer(like PEG) by viscometry method.
8. To study the kinetics of polymerization reaction(Co-polymer synthesis).
9. Determination of molecular weight by viscometry:
   (a) Polyacrylamide-aq.$NaNO_2$ solution
   (b) (Poly vinyl proplylidine (PVP) in water
10. Determination of the viscosity-average molecular weight of poly(vinyl alcohol)(PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
11. Determination of hydroxyl number of a polymer using colorimetric method.
12. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) /Methyl Acrylate (MA) / Acrylic acid (AA).
    a. Purification of monomer
    b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile(AIBN)
13. Redox polymerization of acrylamide
14. Preparation of urea-formaldehyde resin
15. Microscale Emulsion Polymerization of Poly(methylacrylate).

BH020606R- Research Project on topics which are Inter/Intra faculty