**AC 31/08/2015**

**Item No. 4.23**

**UNIVERSITY OF MUMBAI**
**No. UG/98 of 2015-16**

**CIRCULAR:-**

A reference is invited to the Syllabi relating to the B.Sc. degree course, **vide** this office Circular No. UG/179 of 2010, dated 13th July, 2010 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by the Faculty of Science at its meeting held on 11th August, 2015 has been accepted by the Academic Council at its meeting held on 31st August, 2015 **vide** item No. 4.23 and that in accordance therewith, the revised syllabus as per Credit Based Semester and Grading System for the T.Y. B.Sc. programe in Chemistry (Sem.V & Sem. VI), which is available on the University's web site (www.mu.ac.in) that the same has been brought into force with effect from the academic year 2016-17.

13/10/15

REGISTRAR

MUMBAI – 400 032
13th October, 2015

To,

The Principals of affiliated Colleges in Science and the Heads of the recognized Science Institution concerned.

**A.C/4.23/31/08/2015**

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No. UG/98-A of 2015-16 MUMBAI-400 032 13th October, 2015

Copy forwarded with compliments for information to :-

1) The Dean, Faculty of Science,
2) The Director, Board of Colleges and University Development,
3) The Professor-cum-Director, Institute of Distance and Open Learning(IDOL),
4) The Controller of Examinations,
5) The Co-Ordinator, University Computerization Centre.

13/10/15

REGISTRAR

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**AC 31/08/2015**

**Item No. 4.23**

# FACULTY: SCIENCE
# COURSE: B.Sc.
# CHEMISTRY
## Credit Based Semester and Grading System
## SEMESTER V

| Course Code | Unit | Topic | Credits | L/Week |
|---|---|---|---|---|
| **USCH501** | **I** | 1 Molecular Spectroscopy | 2 | 4 |
| | **II** | 2 Electrochemistry-III | | |
| | **III** | 3.1Chemical Thermodynamics-III<br>3.2 Phase Rule | | |
| | **IV** | 4.1 Surface Chemistry & Catalysis<br>4.2 Colloids | | |
| **USCH502** | **I** | 1 Chemical Bonding | 2 | 4 |
| | **II** | 2 Solid State Chemistry | | |
| | **III** | 3 Chemistry of elementsI | | |
| | **IV** | 4Some selected topics | | |
| **USCH503** | **I** | 1 Mechanism of organic reactions | 2 | 4 |
| | **II** | 2 Stereochemistry | | |
| | **III** | 3IUPAC Nomenclature | | |
| | **IV** | 4 Organic Synthesis | | |
| **USCH504** | **I** | 1Treatment Of Analytical Data –Ii And Sampling | 2 | 4 |
| | **II** | 2Separation Techniques-II | | |
| | **III** | 3Optical methods | | |
| | **IV** | 4Titrimetric Analysis | | |
| **USCHP5** | **Practical Course** | | 2 | 9 |

**AC 31/08/2015**
**Item No. 4.23**

## SEMESTER VI

| Course Code | Unit | Topic | Credits | L/Week |
|---|---|---|---|---|
| **USCH601** | **I** | 1.1Chemical Kinetics-III<br>1.2 Polymers-II<br>1.3 Nuclear Magnetic Resonance Spectroscopy | 2 | 4 |
| | **II** | 2 Electrochemistry-IV & Renewable Energy Sources | | |
| | **III** | 3.1Nuclear Chemistry-III | | |
| | **IV** | 4.1Basics of Quantum Mechanics<br>4.2 Crystalline State | | |
| **USCH602** | **I** | 1 Coordination Chemistry | 2 | 4 |
| | **II** | 2 Properties of Coordination compounds | | |
| | **III** | 3 Organomettalic Chemistry | | |
| | **IV** | 4Some selected topics | | |
| **USCH603** | **I** | 1.1 Heterocyclic Chemistry<br>1.2Catalysts and reagents | 2 | 4 |
| | **II** | 2 Chemistry of Bbiomolecules | | |
| | **III** | 3Spectroscopy | | |
| | **IV** | 4.1 Natural Products<br>4.2 Polymers | | |
| **USCH604** | **I** | Electroanalytical Techniques | 2 | 4 |
| | **II** | 2 Food and Cosmetics analysis | | |
| | **III** | 3 Chromatographic Tecniques-II | | |
| | **IV** | 4Thermal and Radioanalytical methods | | |
| **USCHP6** | **Practical Course** | | 2 | 9 |

| **COURSE CODE** | **CREDITS** | |
|---|---|---|
| **USCH501** | **2.5 (60 Lectures)** | |
| **Topic** | | **L/Week** |

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| **1 MOLECULAR SPECTROSCOPY (15L)**<br>**1.1Dipole moment**: polarization of a bond, bond moment, dipole moment and molecular structure.<br>**1.2 *Rotational Spectrum:** Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtainingpurerotational spectrum, selection rule, nature ofspectrum, determination of inter-nuclear distanceand isotopic shift.<br>**1.3 *Vibrational spectrum:** Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum.<br>**1.4 *Vibrational-Rotational(IR) spectrum of diatomic molecule:** vibrating rotor, energy levels, selection rule, nature of spectrum, P and R branch lines, anharmonic oscillator, energy levels, selection rule, fundamental band, overtones . Applications of vibrational-rotational spectrum in determining force constant and its significance, infrared spectra of simple molecules like $H_2O$ and $CO_2$.<br>**1.5*Raman Spectroscopy :**Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum (Stoke's lines and anti Stoke's lines), Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion (example of $CO_2$molecule). | **4** |
| **2.0Electrochemistry-III (15L)**<br>**2.1** Electrochemical cells and its classification, origin of electrode potential.<br>Types of ion specific electrodes-<br>a) Metal –metal ion electrode<br>b) Gas electrode<br>c) Metal Amalgam electrodes<br>d) Metal-metal insoluble salt electrode<br>e) Redox electrode<br>**2.2**Conventions to represent the galvanic cell and reactions<br>**2.3 ***Nernst equation for the single electrode potentialand for the emf of galvanic cell<br>**2.4 ***Lewis concept of activity and activity coefficient, expression for activities of electrolytes<br>**2.5 ***Ionic strength of a solution,<br>**2.6 ***Debye Huckel limiting law (derivation is not expected)<br>**2.7 Classification of cells** | |

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| 2.7.1Chemical cellswith transference and without transference<br>2.7.2 Concentration cells and its classification<br>2.7.3 Origin of liquid junction potential and use of salt bridge<br>2.7.4 Electrode concentration cells<br>2.7.5 *Electrolyte concentration cells with transference and without transference | |
| **3.1CHEMICAL THERMODYNAMICS (8L)**<br>3.1.1 Phases in equilibrium: Clapeyron equation and Clapeyron –Clausius equation.<br>3.1.2 Solutions of Solid in liquid<br>3.1.2.1 *Relative lowering of vapour pressure (derivation is not expected)<br>3.1.2.2 *Elevation of boiling point – Thermodynamic derivation for relation between elevation of boiling point and molality.<br>3.1.2.3 *Depression in freezing point- Thermodynamic derivation for relation between depression in freezing point and molality<br>3.1.3 Osmosis and Osmotic Pressure<br>3.1.3.1 *Thermodynamic derivation of van't Hoff Law<br>3.1. 3.2 Reverse Osmosis<br>**3.2 PHASE RULE (7L)**<br>3.2.1 *Gibbs phase rule: Statement, mathematical expression and terms involved(derivation is not expected)<br>3.2.2 Application of phase rule to one component system: (a) Water system (b) Sulphur system<br>3.2.3 Application of phase rule to two component system: condensed phase rule, eutectic system (Lead-silver system)<br>3.2.4 Three component system: Introduction, graphical representation, phase diagram for three liquids forming one immiscible pair | |
| **4.1 SURFACE CHEMISTRY AND CATALYSIS (8 L)**<br>**4.1.1 *Adsorption:**Physical and Chemical Adsorption, Types of adsorption isotherms , Langmuir's adsorption isotherm (postulates and derivation are expected). B.E.T. equation for multilayer adsorption (derivation is not expected, significance of the terms involved in the equation is expected) determination of surface area of an adsorbent using B.E.T. equation.<br>**4.1.2 Catalysis:** Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation.<br>4.1.2.1 Acid catalysis and Base catalysis, mechanism and kinetics of | |

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| acid and base catalyzed reactions, effect of pH on acid and base catalyzed reactions.<br>4.1.2.2 Enzyme catalysis, mechanism and kinetics of reaction (Michaelis-Menten equation).<br>**4.2 COLLOIDS (7L)**<br>4.2.1 Introduction to colloidal state of matter.<br>4.2.2 Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern model, electrokinetic phenomena: electrophoresis, electro-osmosis, streaming potential and sedimentation potential.<br>4.2.3 Colloidal electrolytes.<br>4.2.4 Donnan Membrane Equilibrium.<br>4.2.5 Surfactants, Micelle formation, application of surfactants in detergents, food industry and pesticide formulations.<br><br>**(*Numerical problems are expected)** | |

| **COURSE CODE** | **CREDITS** | |
|---|---|---|
| **USCH502** | **2.5 (60 Lectures)** | |
| **Topic** | | **L/Week** |
| **1. CHEMICAL BONDING**<br>**1.1 Molecular Symmetry (10L)**<br>1.1.1 Introduction and Importance of symmetry in chemistry.<br>1.1.2 Symmetry elements and symmetry operations.<br>1.1.3 Concept of a Point Group with illustrations using the following point groups: (i) $C_{\alpha v}$ , (ii) $D_{\alpha h}$, (iii) $C_2v$ , (iv) $C_{3v}$ , (v) $C_{2h}$ , and (vi) $D_{3h}$ . | | |

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| 1.2 **Molecular Orbital Theory for Polyatomic pecies (05L)**<br>1.2.1 LCAO-MO for triatomic species: and $H_3$ (correlation between bond angle and Molecular orbitals).<br>1.2.2 Molecular orbital approach for bonding in $AB_2$ molecules. Application of symmetry concepts for linear and angular species considering $\sigma$-bonding only. (Examples like: i) $BeH_2$, ii) $H_2O$) | |
| **2 Solid State Chemistry**<br>**2.1 Structures of Solids (11 L)**<br>2.1.1 Explanation of terms viz. crystal lattice, lattice points, unit cells and lattice constants.<br>2.1.2 Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). Relationship between density of unit cell, lattice parameters. (Numerical problems expected.<br>2.1.3 Metallic Bonding: Band theory, explanation of electrical properties of conductors, insulators and semi-conductors, Intrinsic and extrinsic semiconductors<br>2.1.4Stoichiometric Point Defects in solids<br>**2.2 Superconductivity (04L)**<br>2.2.1 Discovery of superconductivity<br>2.2.2 Explanation of terms like superconductivity, transition temperature, Meissner effect.<br>2.2.3 Different types of super conductors viz. conventional superconductors, alkali metal fullerides, high temperature superconductors.<br>2.2.4 Brief applications of superconductors | **4** |
| **3.0 CHEMISTRY OF ELEMENTS: Inner transition elements(12 L)**<br>**3.1 Introduction**: definition, position in periodic table and electronic Configuration of lanthanides and actinides.<br>**3.2 Chemistry of lanthanides**<br>3.2.1: lanthanide contraction and its consequences,<br>3.2.2: Oxidation states<br>3.2.3: Magnetic and spectral properties<br>3.2.4: Occurrence, extraction and separation of lanthanides by Solvent extraction.<br>3.2.5: Applications of lanthanides.<br>**3.3 Chemistry of actinides (03L)**<br>3.3.1Comparison between lanthanides and actinides<br>3.3.2 Chemistry of Uranium with reference to occurrence, and | |

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| isolation (solvent extraction method)<br>3.3.3Properties and applications of Uranium | |
| **4 SOME SELECTED TOPICS**<br>**4.1 Chemistry in Non-aqueous Solvents (05L)**<br>Classification of solvents and importance of non-aqueous solvents.<br>4.1.1 Super critical carbon dioxide and ionic liquids as solvents<br>4.1.2 Characteristics and study of liquid ammonia, dinitrogen tetra oxide as non-aqueous solvents with respect to: (i) acid-base reactions and (ii) redox reactions.<br>**4.2 Chemistry of Interhalogen (03L)**<br>4.2.1 Introduction,<br>4.2.2 Preparation and uses<br>4.2.3 Bonding.<br>**4.3 Chemistry of pseudohalogens (03L)**<br>4.3.1 Introduction,<br>4.3.2 Preparation,<br>4.3.3 Reactions and structures.<br>**4.4 Chemistry of xenon (04L)**<br>4.4.1 Introduction<br>4.4.2 Compounds of Xenon: Oxides, fluorides and oxyfluorides with respect to preparation, properties and bonding. | |

| **COURSE CODE** | **CREDITS** | |
|---|---|---|
| **USCH503** | **2.5 (60 Lectures)** | |
| **TOPICS** | | **L / week** |
| **1. Mechanism of organic reactions (15L)**<br>1.1 Recapitulation: Curved arrows, intermediates, transition states. Electrophilicityvs acidity &nucleophilicityvs basicity.<br>1.2Elimination reactions: mechanism and stereochemistry.<br>1.2.1 $E_1$, $E_2$ mechanisms, factors influencing the mechanism: nature of substrate, leaving group, structure of base, solvent; | | |

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| Saytzeff and Hofmann elimination; elimination vs substitution<br>1.2.2 E1cB mechanism<br>1.2.3 Pyrolytic elimination: Cope, Chugaev, pyrolysis of acetates<br>1.3 Neighbouring group participation in nucleophilic substitution reactions: participation of lone pair of electrons, kinetics and stereochemical outcome.<br>1.4 Acyl nucleophilic substitution (Tetrahedral mechanism): Acid catalysed esterification of carboxylic acids and base promoted hydrolysis of esters ( $B_{AC}2$).<br>1.5 Mechanism of the following rearrangements with examples and stereochemistry wherever applicable.<br>1.5.1 Migration to electron deficient carbon: Pinacol; Benzilic acid<br>1.5.2 Migration to electron deficient nitrogen: Beckmann, Hofmann.<br>1.5.3 Migration involving a carbanion: Favorski<br>1.6 Name reactions: Michael, Wittig (mechanism and examples). | **4** |
| **2. Stereochemistry (15L)**<br>2.1 Molecular chirality and elements of symmetry:<br>Mirror plane symmetry, inversion centre, rotation-reflection (alternating) axis. Chirality of compounds without a stereogeniccentre: cummulenes, spirans and biphenyls.<br>2.2 Stability of cycloalkanes: Strains in cycloalkanes -angle, eclipsing, transannular (3 to 8 membered).<br>Conformations of cyclohexane, mono and di- alkyl cyclohexanes and their relative stabilities.<br>2.3 Stereoselectivity and stereospecificity: Idea of enantioselectivity (ee) and diastereoselectivity (de). Topicity: enantiotopic and diastereotopic atoms, groups and faces.<br>2.4 Stereochemistry of-<br>(1) Substitution reactions: $S_N1$, $S_N2$, $S_Ni$ (reaction of alcohol with thionyl chloride).<br>(2) Elimination reactions: $E_2$- Base induced dehydrohalogenation of 1-bromo-1,2-diphenylpropane (3) Addition reactions to olefins: i) catalytic hydrogenation ii) bromination (electrophilic anti addition) (iii)syn hydroxylation with OsO4 and KMnO4 (iv) epoxidation followed by hydrolysis, | |

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| **3.1 IUPAC nomenclature (3L)**<br>IUPAC systematic nomenclature of the following classes of compounds (including compounds with upto 2 substituents/ functionalgroups):<br>3.1.1 Bicyclic compounds - spiro, fused, and bridged (upto 11carbon atoms) - saturated and unsaturated compounds.<br>3.1.2 Biphenyls.<br>3.1.3 Cummulenes with upto 3 double bonds.<br>**3.2 Organometallic Chemistry (8L)**<br>3.2.1 Introduction: Carbon-metal bond: Nature, types, reactivity.<br>3.2.2 Organomagnesium compounds: Grignard reagent: Preparation, structure and stability. Reaction with compounds containing acidic hydrogen, carbonyl compounds, $CO_2$, cyanides and epoxides.<br>3.2.3 Organolithium compounds: Preparation using alkyl/aryl halides. Reactions with compounds containing acidic hydrogen, alkyl halides, carbonyl compounds, $CO_2$, cyanides and epoxides. Lithium dialkylcuprates: Preparation and reactions with aliphatic/aromatic/vinylic halides.<br>3.2.4 Organozinc compounds: Reformatsky reaction and Simmons-Smith reaction with mechanism and applications.<br>**3.3. Photochemistry (4L)**<br>3.3.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triplet states, allowed and forbidden transitions, fate of excited molecules, photosensitization.<br>3.3.2 Photochemical reactions of olefins: photoisomerisation, photochemical rearrangement of 1,4-dienes (di $\pi$ methane)<br>3.3.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages. Photoreduction (e.g. benzophenone to benzpinacol). | |
| **4. Synthesis of organic compounds (15L)**<br>**4.1 Introduction:** Criteria for an ideal synthesis, calculation of yields, concept of selectivity with examples.<br>Linear and convergent synthesis with one example each.<br>Multicomponent reactions: Mannich reaction and Hanztsch synthesis. (3L)<br>**4.2 Introduction to Retrosynthesis:**<br>Analysis and synthesis, Technical terms: Target molecule(TM), Retrosynthetic analysis, FGA, FGI, Disconnection, synthon and | |

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| reagent.<br>Retrosynthetic analysis of limonene, salbutamol and proparacaine (3L)<br>**4.3 Green Chemistry and Synthesis**<br>4.3.1 Introduction to Green Chemistry: Definition, need for and importance of green synthesis.<br>Twelve principles of Green Chemistry with examples<br>Atom economy and E- factor, calculations and their significance.<br>Examples of reactions with low and high atom economy<br>4.3.2 Green Synthesis in Industry:<br>Green starting materials: D-glucose to adipic acid.<br>Green reagents: Selective methylation of active methylene using dimethyl carbonate<br>Green solvents: supercritical $CO_2$, Deep eutectic solvents (DES)<br>Green catalysts: Heterogeneous catalysis using Tellurium, Biocatalysis.<br>Green synthesis of paracetamol (green context to be emphasized) (6L)<br>**4.4 Other methods of organic synthesis**<br>Microwave assisted organic synthesis (using organic solvents and in solid state). Ultrasound in organic synthesis. Phase transfer catalysis.<br>Polymer supported synthesis: Merrifield polypeptide synthesis (3L) | |

| **COURSE CODE** | **CREDITS** | |
|---|---|---|
| **USCH504** | **2.5 (60 Lectures)** | |
| **Topic** | | **L/Week** |
| **1 TREATMENT OF ANALYTICAL DATA –II AND SAMPLING**<br>**a. Treatment of analytical data – II (08L)**<br>1.1.1 Distribution of measurements and results : Normal (Gaussian) distribution curve and its characteristics .Test of Significance –Null hypothesis<br>1.1.2 Confidence limit (CL), Confidence interval(CI)– Student's 't' test (t test) ,CI when σ is known , CI when σ is unknown(z-test) , | | |

comparison to a true mean, comparison of two means , comparison of standard deviations (F-test) .Steps for statistical analysis of data, CHI Square test. Criteria for Rejection of results –Q test

1.1.3 Graphical representation of results- Method of least squares, regression equation for a straight line passing through the origin, regression equation for a straight line having an intercept

**1.2 Sampling (07 L)**

1.2.1 Importance of sampling, Terms involved in sampling, Sampling techniques, Sampling techniques

1.2.2 Types of sampling a) Random sampling b) Non-random sampling. Difficulties encountered in sampling

1.2.3 Sampling of gases, Ambient and stack sampling : Apparatus and methods for sampling of gases

1.2.4 Sampling of liquids, Sampling of Homogeneous and Heterogeneous Liquids, Sampling of static and flowing liquids

1.2.5 Sampling of solids, Sample size – bulk ratio, size to weight ratio , multistage and sequential sampling , size reduction methods , sampling of compact solids , equipments and methods of sampling of compact solids , sampling of particulate solids, method and equipments used for sampling of particulate solids, Collection, preservation and dissolution of the sample

**2 SEPARATION TECHNIQUES – II**

**2.1 Chromatography (02 L)**

Introduction to Chromatography, Classification of Chromatographic Methods

**2.2 Planar Chromatography (04 L)**

2.2.1 Principle of Thin Layer Chromatography (TLC), Retardation factor $R_f$

2.2.2 Techniques in Thin Layer Chromatography

A) Stationary phase- coating materials

B) Preparation of Plates

C) Mobile phase- Selection of Solvents

D)Methods of Plate Development- Ascending development, Descending Development, Two dimensional Development, Continuous Development, and Multiple Development.

E) Detection methods for locating separated components: Qualitative analysis and Quantitative analysis.

2.2.3 Applications of Thin layer chromatography

2.2.4 Principle of Paper Chromatography(PC)

2.2.5 Techniques in paper Chromatography

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| A) Stationary phase<br>B) Preparation of the Sample<br>C) Application of the Sample<br>D) Mobile phase - Solvent System<br>E) Development of paper chromatogram:<br>Ascending Development, Descending Development , Horizontal Development, Radial Development, Multiple Development, Two dimensional Development<br>F) Detection and Quantitative analysis- Physical methods, Chemical methods, Enzymatic and biological methods of detection<br>2.2.6Applications of Paper chromatography<br>2.2.7 Comparison of PC and TLC<br>2.3 **High Performance Liquid chromatography (HPLC) (06 L)**<br>**2.3.1** Introduction to HPLC<br>2.3.2 Instrumentation in HPLC<br>A) Solvent Reservoir<br>B) Degassing system- Filtration, Distillation, Sparging inert gas<br>C) Pumps-Reciprocating pumps, Screw driven- syringe type pumps, Pneumatic pumps , advantages and disadvantages of each pump. | |
| D) Precolumns<br>E) Sample injection system<br>F) HPLC Columns<br>G) Detectors: Ultraviolet – Visible detector, Refractive index detector. Advantages and Limitations of each detector.<br>2.3.3 Applications of HPLC<br>2.4 **High Performance Thin Layer Chromatography (HPTLC) (03 L)**<br>2.4.1 Introduction to HPTLC<br>2.4.2 Techniques in HPTLC<br>A) Stationary Phase<br>B) Sample Application<br>C) Mobile phase<br>2.4.3 Determination by Detectors in HPTLC.<br>Detectors: Single beam densitometer, Double beam densitometer, Flourimetric Detector<br>2.4.4 Comparison between TLC and HPTLC<br>2.4.5 Advantages and Limitations of HPTLC<br>2.4.6 Applications of HPLTLC | |

**3.0 OPTICAL METHODS**

**3.1 Atomic Spectroscopy (07 L)**

**3.1.1** Absorption and Emission Spectra

3.1.2 Energy level diagrams

3.1.3 Flame Photometry – Principle, Instrumentation (Flame atomizers, Types of Burners, Wavelength Selectors, Detectors)

3.1.4 Atomic Absorption Spectroscopy – Principle, Instrumentation (Source, Chopper, Flame and Electrothermal Atomizer)

3.1.5 Quantitative applications of Flame Photometry and Atomic Absorption Spectroscopy – Calibration curve method, Standard addition method and Internal standard method.

3.1.6 Comparison of Flame Photometry and Atomic Absorption Spectroscopy

3.1.7 Applications and Limitations of Flame Photometry and Atomic Absorption Spectroscopy.

**3.2 Molecular Fluorescence and Phosphorescence Spectroscopy (04L)**

3.2.1 Theory of Molecular Fluorescence and Phosphorescence Spectroscopy.

3.2.2 Jablonski Diagram of Energy Levels.

3.2.3 Relationship between Fluorescence intensity and concentration, Factors affecting Fluorescence and Phosphorescence.

3.2.4 Instrumentation and Applications of Fluorimetry and Phosphorimetry.

3.2.5 Comparison ofFluorimetry and Phosphorimetry.

3.2.6 Comparison of Fluorimetry with Absorption methods.

**3.3 Turbidimetry and Nephelometry (04L)**

3.3.1 Scattering of Radiations.

3.3.2 Factors affecting scattering of Radiation: Concentration, particle size, wavelength, refractive index.

3.3.3 Instrumentation and Applications of Turbidimetry and Nephelometry .

**4TITRIMETRIC ANALYSIS**

**4.1Redox titrations (04 L)**

4.1.1 General Introduction

4.1.2 Construction of the titration curves and calculation of $E_{system}$ in case of (1) Fe(II) Vs. Ce(IV) (2) Fe(II) Vs. $KMnO_4$.

4.1.3 Theory of redox indicators, criterion for selection of an indicator for a redox titration, Use of diphenyl amine and ferroin as redox indicators. (Numerical problems expected).

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| **4.2 Molecular Spectroscopy – III (04 L)**<br>4.2.1 Recapitulation of basic concepts<br>4.2.2 Instrumentation, Principle and working of single and double beam spectrophotometers.<br>4.2.3 Applications of UV- Visible Spectrophotometry.<br>**4.3 Solvent Extraction – II (07 L)**<br>4.3.1 Recapitulation<br>4.3.2 Factors affecting extraction in detail: Chelation, Ion pair formation and Solvation, Synergistic solvent extraction<br>4.3.3 Craig's counter current extraction: Principle, apparatus and applications<br>4.3.4 Use of Crown ethers in solvent extraction.<br>4.3.5 Solid phase extraction: Principle, process and applications.<br>4.3.6 Advantages of solid phase extraction over solvent extraction and limitations. | |

**Practical Course USCHP5**
**Experiments based on USCH501**

1. To determine the standard reduction potential of $Cu^{2+}/Cu$ electrode at room temperature. (3 and 6 units)
2. To determine the amount of Fe (II) in the given solution by titration with a standard $K_2Cr_2O_7$ solution and hence to find the formal redox potential of $Fe^{3+}/Fe^{2+}$. (3 and 6 units)
3. To study the effect of ionic strength on the rate of reaction between $K_2S_2O_8$ and KI using KCl. (3 and 6 units)
4. To study the rate of adsorption of acetic acid on activated charcoal. (6 units)
5. To study the relative strength of acetic acid and monochloroacetic acid. (6 units)
6. To study the empirical formula of the complex between Fe(III) and salicylic acid by static titration method. (6 units)

**Experiments based on USCH502**

Preparation

I) Chromium(II) acetate.

II) $Cu(Ox)(H_2O)_2$

III) Prussian Blue

IV) $Zn(NH3)_4.I_2$

2. Experiments with Models.

3. Determination of Composition of a mixture of a mixture of strong and weak acid by titration with a strong base using a suitable indicator.

**Experiments based on USCH503**

1. Separation of binary (solid – solid) mixture. (Weights and physical constants of both crude components of the mixture are to be reported) (Minimum 8 mixtures)
2. Identification of an organic compound of known chemical type. (Minimum 8 compounds)

**Experiments based on USCH504**

1. To determine the amount of Fluoride present in the given solution colorimetrically.(3 and 6 units)
2. Estimation of Vitamin C in the given solution by titration with Cerric ammonium Sulphate.(3 and 6 units)
3. To determine potassium content of a commercial salt sample by Flame Photometry. (3 and 6 units).
4. To determine the amount of sulphate present in the given water sample turbidimetrically.(6 Units)
5. To determine the amount of persulphate in the given solution by back titration with standard Fe (II) ammonium sulphate solution.(6 Units).
6. To estimate Fe(II) in a tablet using Diphenylamine as an indicator. (6Units)

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| COURSE CODE | CREDITS | |
|---|---|---|
| USCH 601 | 2.5 (45 Lectures) | |
| TOPICS | | L/Week |
| **1.1CHEMICAL KINETICS-III (5L)**<br>1.1.1 ***Collision theory of reaction rates**, applications of collision theory to bimolecular reaction and unimolecularreaction(Lindemann's theory, derivation expected). Merits and demerits of Collision theory.<br>1.1.2 **Concept of Activated complex,** Activated complex theory theory of bimolecular reactions ( derivation expected).<br>1.1.3 **Classification of reactions**- slow, fast and ultra fast, study of kinetics of fast reactions by STOP FLOW method<br>**1.2 POLYMERS-II (5L)**<br>**1.2.1 Classification of polymers** based on (i) source, (ii) structure, (iii) thermal response, (iv) physical properties.<br>**1.2.2 *Molar mass of polymers**: 1. Number average molar mass, 2.Weight average molar mass, 3. Viscosity average molar mass, monodispersity, polydispersity, polydisperity index<br>**1.2.3 *Methods of determining molar mass of polymers** : (i) Principle, limitation and application of Ultracentrifugation method (ii) Viscosity method-Principle, experimental determination of Viscosity average molar mass, Mark-Houwink equation.<br>**1.3 NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (5L)**<br>**1.3.1**. Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in NMR ( spin-spin relaxation and spin-lattice relaxation).<br>**1.3.2**. NMR Spectrometer, chemical shift, shielding and deshielding of protons, low resolution NMR spectrum of methanol and ethanol. | | **4** |
| **2.0ELECTROCHEMISTRY- IV& RENEWABLE ENERGY SOURCES (15L)**<br>**2.1Applied electrochemistry**<br>2.1.1 Application of emf measurement in the determination of –<br>i) *pH of a solution using quinhydrone and glass electrode,<br>ii) *Solubility and solubility product of sparingly soluble salt using chemical and concentration cells,<br>iii) determination of liquid junction potential<br>iv) determination of thermodynamic parameters ($\Delta G$, $\Delta H$ and $\Delta S$) for the cell reaction and equilibrium constant. | | |

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| 2.1.2 Decomposition potential and its experimental determination, *Over voltage and its experimental determination, *Tafel's equation for hydrogen overvoltage,<br>Electroplating objective and theory<br>**2. 2Renewable energy sources:**<br>Hydrogen - fuel of future, Advantages of hydrogen as a universal energy medium, Bacon's $H_2$ and $O_2$ fuel cell, Lithium ion cell, Silicon solar cell. | |
| **3.0NUCLEAR CHEMISTRY-III (15L)**<br>**3.1Detection and measurement of radioactivity** – GM Counter and Scintillation Detector<br>**3.2*Radioactive Equilibrium**- 1) Secular 2) Transient ; differences between chemical and radioactive equilibrium ;<br>**3.3 Use of radioisotopes-**as tracers in chemical investigation –<br>i) reaction mechanism ii) Medical applications<br>**3.4Nuclear reactions:** Nuclear Transmutation and artificial radioactivity –, Mechanism; Different types of projectiles –<br>1) alpha particles 2) neutrons;<br>**3.5Mode of decay** of artificially radioactive elements – 1) emission of positrons 2) emission of electrons 3) K-electron capture<br>**3.6 Nuclear energy:**<br>3.6.1 *Conservation of energy – Q value, Threshold energy.<br>**3.6.2**Nuclear Fission – Process, Fission fragments, Fission Energy; Factors controlling Nuclear Fission – 1) Critical Mass 2) Multiplication Factor<br>**3.7.3**Nuclear Power Reactors- Basic components (including schematic); Breeder Reactor – Fissile and Fertile material. Nuclear Power Reactors in India<br>**3.7.4** Nuclear Fusion - Characteristics; Thermonuclear Reactions occurring on 1) Stellar bodies 2) Earth | |
| **4.1 BASICS OF QUANTUM CHEMISTRY (8L)**<br>**4.1.1** Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.<br>**4.1.2** Introduction to quantum mechanics, Planck's theory of quantization, wave particle duality, de-Broglie equation, Heisenberg's uncertainty principle.<br>**4.1.3** Postulates of quantum mechanics ( following are to be considered),1. state function and it's significance2. *Concept of operators : definition, addition, subtraction and multiplication of operators, commutative and non- commutative operators, linear operator, Hamiltonian operator, 3. *Eigen function and eigen value, eigen value | |

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| equation.<br>**4.2 CRYSTALLINE STATE (7L)**<br>**4.2.1.** Laws of Crystallography<br>**4.2.2**. Characteristics of simple cubic, face centered and body centered cubic system, inter planar distance in cubic lattices (only expressions for ratios of inter planar distances are expected ).<br>**4.2.3 ***Use of X- rays in the study of crystal structure, Bragg's equation ( derivation expected), X- ray diffraction method of studying crystal lattices, structure of NaCl, determination of Avogadro number. | |

| **COURSE CODE** | **CREDITS** |
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| **USCH602** | **2.5 (60 Lectures)** |

| **Topic** | **L/Week** |
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| **1 COORINATION CHEMISTRY**<br>**1.1 Theories of the metal-ligand bond (10L)**<br>1.1.1 Limitations of VBT<br>1.1.2 Crystal field theory and effect of crystal field on central metal valence orbitals in various geometries<br>1.1.3Splitting of *d* orbitals in octahedral, square planar and tetrahedral crystal fields.<br>1.1.4 Distortions from the octahedral geometry: (i) effect of ligand field and (ii) Jahn-Teller distortions<br>1.1.5 Crystal field splitting parameter Δ; its calculation and factors affecting it in octahedral complexes,Spectrochemical series<br>1.1.6Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral complexes with $d^0$ to $d^{10}$ metal ion configurations.<br>1.1.7Consequences of crystal field splitting on various properties such as ionic radii, hydration energy and enthalpies of formation of metal complexes of the first transition series.<br>1.1.8Limitations of CFT: Evidences for covalence in metal complexes (i) intensities of d-d transitions, (ii) ESR spectrum of $[IrCl_6]^{2-}$ (iii) Nephelauxetic effect.<br>**1.2Molecular orbital theory for coordination compounds (05L)**<br>1.2.1Identification of the central metal orbitals and their symmetry suitable for formation of σ-bonds with ligand orbitals<br>1.1.2Construction of ligand group orbitals<br>1.1.3Construction of σ- molecular orbitals for an $ML_6$ complex. | **4** |
| **2 PROPERTIES OF COORDINATION COMPOUNDS**<br>**2.1Electronic Spectra (07 L)** | |

2.1.1Origin of electronic spectra
2.1.2Types of electronic transitions in coordination compounds: intra-ligand, charge transfer and intra-metal transitions.
2.1.3Electronic configuration and electronic micro states, Terms and Term symbols, coupling of spin momenta ($M_s$), orbital momenta ($M_l$) and spin- orbit coupling or Russell-Saunders coupling.
2.1.4Determination of Terms for $p^2$ and $d^2$ electronic configurations.
2.1.5Terms and micro-states for transition metal atoms/ions.
2.1.6Orgel Diagrams for D and F Terms (i.e. $d^1$*, to* $d^9$ electronic configurations in octahedral crystal fields)
2.1.7Selection Rules for electronic transitions: Spin and Orbital forbidden transitions. (Laporte selection rules.)

**2.2Stability of Metal-Complexes (04L)**

2.2.1Thermodynamic and kinetic perspectives of metal complexes with examples.
2.2.2Stability constants: Stepwise and overall stability constants and their inter-relationship.
2.2.3 Factors affecting thermodynamic stability.

**2.3 Reactivity of Metal-complexes. (04L)**

2.3.1Comparison between Inorganic and organic reactions
2.3.2Types of reactions in metal complexes.
2.3.3 Inert and labile complexes: correlation between electronic configurations and lability of complexes.
2.3.4 Ligand substitution reactions: Associative and Dissociative mechanisms.
2.3.5Acid hydrolysis, base hydrolysis and anation reactions.

**3ORGANOMETTALIC CHEMISTRY**

**3.1Organometallic Compounds of main group metal (06L)**

3.1.1General characteristics of various types of organometallic compounds, viz. ionic, σ-bonded and electron deficient compounds.
3.1.2General synthetic methods of organometallic compounds: (i) Oxidative-addition, (ii) Metal-metal exchange (transmetallation), Carbanion-halide exchange, (iv) Metal-hydrogen exchange (metallation) and (v) Methylene-insertion reactions.
3.1.3Some chemical reactions of organometallic compounds:
(i) Reactions with oxygen and halogens, (ii) Alkylation and arylation reactions, (iii) Reactions with protic reagents, (iv) Redistribution reactions, and (v) Complex formation reactions

**3.2Metallocenes:** Introduction, Ferrocene: Synthesis, properties, structure and bonding on the basis of VBT.

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| **3.3Catalysis: (04L)**<br>3.3.1Overview of Homogenous catalysis;<br>3.3.2Selection of catalytic cycles;<br>3.3.3Coupling Reactions: Heck and Suzuki reactions. | |
| **3SOME SELECTED TOPICS**<br>**4.1 Nanomaterials (08L)**<br>4.1.1Introduction and importance of nanomaterials.<br>4.1.2Chemical methods of synthesis of nanomaterials<br>4.1.3Charecterisation of nanomaterials; (UV and XRD techniques)<br>4.1.4Dimensions and forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, and nanoparticles.<br>4.1.5Properties (Comparison between bulk and nanomaterials): (i) Optical (ii) Electrical and (iii) Mechanical properties.<br>4.1.6Applications<br>**4.2Bio inorganic and medicinal chemistry (07 L)**<br>4.2.1Metal coordination in biological systems: Enzymes, apoenzymes and coenzymes<br>4.2.2Biological role of carboxypeptidases, catalases, and peroxidases.<br>4.2.3Metal complexes in medicine: cis-platins and gold complexes<br>4.2.4Inorganic radiopharmaceuticals. | |

| **COURSE CODE** | **CREDITS** | |
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| **USCH603** | **2.5 (60 Lectures)** | |
| **TOPICS** | | **L / week** |
| **1.1. HETEROCYCLIC CHEMISTRY (8L)**<br>1.1.1 Introduction: Electronic structure and aromaticity of furan, pyrrole, thiophene and pyridine.<br>1.1.2 Synthesis of furans, pyrroles, and thiophenes by Paal-Knorr synthesis, pyridines by Hantzsch synthesis and from 1,5-diketones.<br>1.1.3 Reactivity of furan, pyrrole and thiophene towards aromatic electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine to aromatic nucleophilic substitution on the basis of<br>electron distribution.<br>1.1.4 Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulfonation, VilsmeierHaack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole | | |

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| and pyrrolidine.<br>Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulfonation of pyridine (with and without catalyst). Reduction. Action of sodamide (Chichibabin reaction).<br>1.1.5 Pyridine-N-oxide: Preparation, reactivity to electrophilic and nucleophilic substitution based on electron distribution in the molecule.<br>**1.2 CATALYSTS AND REAGENTS (7L)**<br>Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).<br>**1.2.1 Catalysts**: Catalysts for hydrogenation: Raney Ni, Pt and PtO2: C=C, CN, NO2, aromatic ring; Pd/C: C=C, COCl→CHO (Rosenmund); Lindlar catalyst: alkynes; Wilkinson's catalyst: olefins.<br>**1.2.2 Reagents**: (1) LiAlH4 and Red-Al: reduction of CO, COOR, CN, NO2. (2) NaBH4: reduction of CO (3) SeO2: hydroxylation of allylic and benzylic positions, oxidation of $CH_2$ (alpha to CO) to CO. (4) mCPBA: epoxidation of C=C.<br>(5) NBS: allylic and benzylicbromination. | |
| **2. Chemistry of biomolecules. (15L)**<br>**2.1 Carbohydrates**<br>2.1.1 Introduction: classification, reducing and non-reducing sugars, DL notation.<br>2.1.2Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides) and Haworth formula (furanose and pyranose forms of pentoses and hexoses)<br>Interconversion: open chain and Haworth forms of monosaccharides with 5 & 6 carbons.<br>Chair conformation with stereochemistry of D-glucose. Stability of chair form of D-glucose.<br>2.1.3 Stereoisomers of D-glucose: enantiomer, diastereomers, anomers, epimers.<br>2.1.4 Mutarotation in D-glucose with mechanism<br>2.1.5 Chain lengthening & shortening reactions:<br>Modified Kiliani-Fischer synthesis (D-arabinose to D-glucose & D-mannose), Wohl method (D-glucose to D-arabinose)<br>2.1.6 Reactions of D-glucose and D-fructose:<br>a) osazone formation b) reduction: $H_2$/Ni, $NaBH_4$ c) oxidation: bromine water, $HNO_3$, $HIO_4$ d) acetylation e) methylation [d) and e) with cyclic pyranose forms] | |

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| 2.1.6 Glycosides: general structure, formation of alkyl glycosides and anomeric effect.<br>2.1.7 Disaccharides: Structures of sucrose and maltose. (cyclic forms: Haworth/chair) (Structure determination not expected.) (9L)<br>**2.2 Amino acids and Proteins**<br>2.2.1 α- amino-acids: General structure, configuration, essential (valine,leucine, phenylalanine), neutral (glycine, alanine), acidic (glutamic acid) and basic (lysine) amino-acids. (systematic names with abbreviations). pH dependency of ionic structure and isoelectric point<br>2.2.2 Polypeptides and Proteins:<br>Nature of peptide bond, nomenclature and representation of peptides (di and tripeptides)<br>Proteins: general idea of primary, secondary, tertiary and quaternary structure. (2L)<br>**2.3 Nucleic acids**<br>Controlled hydrolysis of nucleic acids.Sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structures of nucleic acids (DNA and RNA) including base pairing. (3L)<br>**2.4 Lipids**<br>Introduction and classification (1L | |
| **3. SPECTROSCOPY(15L)**<br>**3.1 Introduction** : Electromagnetic spectrum, units of wavelength and frequency.<br>**3.2 UV- Visible spectroscopy**: Basic theory, solvents, nature of UV-Vis spectrum, concept of chromophore, auxochrome, bathochromic and hypsochromic shifts, hyperchromic and hypochromic effects, chromophore- chromophore and chromophore-auxochrome interactions.<br>**3.3 IR spectroscopy**: Basic theory, selection rule, nature of IR spectrum, characteristic vibrational frequencies of functional groups, fingerprint region.<br>**3.4 PMR spectroscopy**: Basic theory of PMR, nature of PMR spectrum, chemical shift (∂ unit), standard for PMR, solvents used. Factors affecting chemical shift: inductive effect and anisotropic effect (with reference to C=C, CΞC, C=O and benzene ring). Spin-spin coupling and<br>coupling constant. Application of deuterium exchange technique. | |

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| **3.5 Spectral characteristics** of the following classes of organic compounds including benzene and monosubstituted benzenes with respect to UV-Vis, IR and PMR: (1) alkanes (2) alkenes and polyenes (3) alkynes (4) haloalkanes (5) alcohols (6) carbonyl compounds (7) ethers (8) carboxylic acids (9) esters (10)amines (11) amides (broad regions characteristic of different groups are expected).<br>**3.6 Mass spectrometry**: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, Nitrogen rule. Fragmentation of alkanes and aliphatic carbonyl compounds including Mclafferty rearrangement.<br>**3.7 Problems on structure elucidation** of simple organic compounds using individual/ combined use of the above spectroscopic techniques. (Index of hydrogen deficiency expected). | |
| **4.1. NATURAL PRODUCTS (8L)**<br>4.1.1 Introduction to the following natural products (structures of compounds specified are expected)<br>a)Terpenoids: Isoprene rule, Special isoprene rule, α-terpeniol, citral, camphor, α –pinene.<br>b) Alkaloids: Nicotine, atropine<br>c) Vitamins: Vitamin A, Vitamin C<br>d) Hormones: Adrenaline,Thyroxine<br>e) Steroids: Cholesterol, progesterone.<br>4.1.2 Structure determination of natural products<br>a) Ozonolysis in terpenenoids: Examples of open chain and monocyclic monoterpenoids.<br>b) Hofmann exhaustive methylation and degradation in alkaloids: simple open chain and monocyclic amines.<br>4.1.3 Commercial synthesis: a) camphor from α-pinene, b) α and β ionones from citral.<br>4.1.4 Introduction to primary and secondary metabolites and broad classification of natural products based on bio-synthesis.<br>**4.2. POLYMERS (7L)**<br>4.2.1 Introduction: Review of terms – monomer, polymer, homopolymer, copolymer, thermoplastics and thermosets.<br>4.2.2 Addition polymers: polyethylene, polypropylene, teflon, polystyrene, PVC. Uses, recycling.<br>4.2.3 Condensation polymers: polyesters, polyamides, | |

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| polyurethanes, polycarbonates, phenol-formaldehyde resins. Uses<br>4.2.4 Mechanism of free radical addition polymerization.<br>4.2.5 Stereochemistry of polymers: Tacticity, Mechanism of stereochemical control of polymerization using Ziegler Natta catalysts.<br>4.2.6 Natural and synthetic rubbers: Polymerisation of isoprene: 1,2 and 1,4 addition (cis and trans), Styrene-butadiene copolymer.<br>4.2.7 Additives to polymers: Plasticisers, stabilizers and fillers.<br>4.2.8 Biodegradable polymers: Classification and uses. Polylactic acid – structure, properties and use for packaging and medical purposes.<br>(Note: Identification of monomer in a given polymer and structure of polymer from given monomer(s) is expected. Conditions for polymerization not expected) | |

| **COURSE CODE** | **CREDITS** | |
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| **USCH604** | **2.5 (60 Lectures)** | |
| **Topic** | | **L/Week** |
| **1 ELECTRO ANALYTICAL TECHNIQUES**<br>**1.1 Potentiometric Titrations ( 03L)**<br>1.1.1 Cell potential, writing cell expression, notations and | | |

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| meanings etc.<br>1.1.2 Potentiometric titrations: acid base titration and variation of electrode potential and cell emf.<br>1.1.3 Potentiometric titration curves: nature of curves and determination of equivalence point by different methods.<br>1.1.4 Applications of potentiometric titrations.<br>**1.2 Polarography (08L)**<br>1.2.1 Difference between potentiometry and voltammetry, Basic principle of polarography, Polarizable and Non-polarizable electrodes.<br>1.2.2 Polarizable and Non-polarizable electrodes, Dropping Mercury Electrode (DME) construction, working advantages and limitations, Three electrode system.<br>1.2.3 Supporting electrolyte, its role, selection of supporting electrolyte.<br>1.2.4 DC polarogram: understanding of the terms - Residual current, diffusion current, limiting current, Half wave potential, Polarographic maxima and maxima suppressors, Interference of oxygen and its removal.<br>1.2.5 Ilkovic Equation and various terms involved in it (Derivation not expected).<br>1.2.6 Applications and advantages of polarography.<br>**(Numerical Problems Expected).**<br>**1.3 Amperometric titrations (04L)**<br>1.3.1 Comparison between Amperometry and voltammetry.<br>1.3.2 Basic principle of amperometry<br>1.3.3 Rotating platinum electrode: Instrumentation, advantages and limitations.<br>1.3.4 Amperometric titrations: Examples and titration curves.<br>1.3.5 Applications, advantages and limitations | |
| **2 FOOD AND COSMETICS ANALYSIS**<br>**2.1 Introduction to food chemistry (10L)**<br>2.1.1 Food processing and preservation: Introduction, need<br>Methods of food processing and preservation<br>Chemical methods :<br>1)Use of chemicals as preservatives(volatile fatty acids in Bakery products, Benzoic acid in jam and jellies, Acetic acid in pickles,Lactic acid in poultry, sulfite in fruits)<br>2)Role of pH on the preservation of foo<br>Physical methods :1) Pasteurization 2) Irradiation | |

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| 2.1.2 Determination of Boric acid and Sodium benzoate as preservatives.<br>2.1.3 Study and analysis of food products – Milk:<br>Composition, nutrients in milk, types of milk (fat free, Organic and lactose milk), analysis of milk for lactose.<br>2.1.4 Study and analysis of food products – Honey:<br>Composition of honey, analysis of reducing sugars in honey.<br>2.1.5 Study and analysis of food products – Tea:<br>Composition of tea, types of tea (green tea and black tea), analysis of tea for Tannin.<br>2.1.6 Study and analysis of food products – Coffee:<br>Constituents and composition of coffee, role of Chicory in coffee, analysis of coffee for caffeine<br>**2.2 Cosmetics (05L)**<br>2.2.1 Introduction and sensory properties of cosmetics.<br>2.2.2 Study of cosmetic products;<br>**a) Face powder**: Composition, estimation of calcium and magnesium. b) **Lipstick**: Constituents, ash analysis.<br>**c) Deodorants and Antiperspirants**: Constituents, properties, estimation of chlorides and zinc. | |
| **3 CHROMATOGRAPHIC TECHNIQUES – II**<br>**3.1 Gas Chromatography (GC) ( 08L)**<br>3.1.1 Introduction, Basic Principle, Terms involved in GC (**Numerical Problems Expected**)<br>3.1.2 Instrumentation of Gas Chromatography: Block Diagram and components.<br>3.1.3 Columns and their packing in GSC and GLC<br>3.1.4 Different types of detectors :TCD,FID,ECD<br>3.1.5 Quantitative and Qualitative analysis<br>3.1.6 Comparison between GSC and GLC<br>3.1.7 Applications of GC<br>**3.2 Ion Exchange Chromatography ( 05L)**<br>3.2.1 Introduction, Types of Ion Exchangers and their examples Ideal properties of Resin.<br>3.2.2 Ion Exchange equilibria and mechanism, Selectivity coefficient and separation factor.<br>3.2.3 Factors affecting separation of ions.<br>3.2.4 Ion Exchange capacity and its determination.<br>3.2.5 Applications of Ion Exchange Chromatography - Preparation of demineralised water, Separation of Lanthanides, Preparation of exact | |

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| concentration of acid or base, Separation of amino acids .<br>**3.3 Size Exclusion Chromatography (SEC) (02L)**<br>3.3.1Introduction, Basic Principle, Applications of SEC | |
| **4 THERMAL AND RADIOANALYTICAL METHODS**<br>**4.1 Thermal Methods (11L)**<br>4.1.1 Introduction, Different methods of thermal analysis (TGA and DTA ).<br>4.1.2 **Thermogravimetric methods of analysis:** Instrumentation-basic components of thermobalance - block diagram(balance, furnace, temperature measurement and control, recorder), Thermogram (TG curve)- Factors affecting TG curve -Instrumental factors (Furnace heating rate, furnace atmosphere ,geometry of the sample holder) and Sample characteristics (effect of sample mass, effect of sample particle size and effect of heat of reaction), Applications of TGA - TGA of $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$ - Determination of Drying temperature range and ignition temperature.<br>4.1.3 **Differential Thermal Analysis (DTA):** Principle**,** Instrumentation –balance ,thermocouple- Reference material used in DTA($MgO$,$Al_2O_3$,$SiC$), DTA curve , Applications : DTA of $CaC_2O_4.H_2O$ and $CuSO_4.5H_2O$, Difference between TGA and DTA.<br>4.1.4 **Thermometric Titrations –**Introduction**,**Instrumentation, Applications in the titration of :<br>(i) HCl v/s NaOH (ii) Boric acid v/s NaOH<br>(iii) A mixture of $Ca^{+2}$ and $Mg^{+2}$ v/s EDTA<br>(iv) $Zn^{+2}$ with Disodium Tartarate**.**<br>**4.2 Radioanalytical Methods (04L)**<br>4.2.1 Introduction , Classification of Radioanalytical Techniques<br>4.2.2 Neutron Activation Analysis(NAA) – Principle and Theory.<br>4.2.3 Advantages and Limitations of NAA<br>4.2.4 Applications of NAA | |

**Practical course USCHP06**

**Experiments based on USCH601**

1. To determine the solubility and solubility product of AgClpotentiometrically using chemical cell. (3 and 6 units)
2. To determine the strength of the given strong acid (HCl) by potentiometric titration using quinhydrone electrode. (3 and 6 units)

3. To determine the energy of activation for the acid catalyzed hydrolysis of methyl acetate. (3 and 6 units)

4A.To determine the pKa value of weak monobasic acid by emf measurements. (6 units)

OR

4B. To determine acidic and basic dissociation constant of amino acid and hence calculate isoelectric point. (6 units)

5.To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement. (6 units)

6.To determine the thermodynamic parameters of for the following reaction (6 units)

**Experiments based on USCH602**

1. Preparations

I) Vanadium(II) $(AcAc)_2$
II) $Cu(HgI_4)$
III) $Hg(Co(SCN)_4)$
IV) $Cu(NH_3)_4.Cl_2$

2. Identification of crystals by using compound microscopes.
3. Redox titrations.

**Experiments based on USCH603**

I. Separation of binary (solid - liquid / liquid – liquid) mixture.
(Weights/volumes and physical constants of both crude components to be reported)
(Minimum 6 mixtures)

II. Organic Preparations
i. Acetylation of hydroquinone
ii. Nitration of acetanilide/ nitrobenzene
iii. Hydrolysis of ethyl benzoate
iv. Hydrolysis of p - nitroacetanilide
v. Bromination of acetanilide
vi. O-methylation of β – naphthol

(Purification of entire crude product expected)

**Experiments based on USCH604**

1. Estimation of Chromium in water sample spectroscopically by using Diphenylcarbazide.(3 and 6 Units).
2. Estimation of Calcium and magnesium content in Talcum powder. (3 and 6 Units) .
3. Estimation of reducing sugar in honey by Wilstatter method.( 3 and 6 Units)

4. Separation and estimation of Mg(II) and Zn(II) from given sample solution using an anion exchanger.(6 Units)
5. Estimation of acetic acid in Vinegar sample by using Quinhydrone electrode potentiometrically.(6 Units)
6. Determination of phosporic acid in cola sample pH metrically. (6 Units)

# AC 31/08/2015
# Item No. 4.23

TO BE IMPLEMENTED FROM 16-17

If Government of Maharashtra does not sanction the change the applied component will remain same as it is only change in name as given below will be there

1. Drugs will be **Pharmaceutical chemistry**

2. Dyes will be **Paints and Dyestuff**

If Government of Maharashtra sanctions the change in nomenclature and structure of applied component then there will be two groups of electives as given below

##Group I-- Discipline specific electives

1. Novel inorganic solids
2. Polymer Chemistry
3. Research Methodology for chemistry
4. Green Chemistry
5. Industrial Chemistry and Environment
6. Inorganic Materials on Industrial Importance
7. Heavy and Fine Chemicals
8. Petrochemicals
9. Renewable Energy Resources

## Group II --Skill development Electives

1. Chemical Tchnology and Society
2. Chemo-informatics
3. Business Skill for Chemists
4. Intellectual Property Rights
5. Analytical Clinical Biochemistry
6. Green Methods in Chemistry

## SYLLABUS FOR **DSE & SDE** ELECTIVES IS AS PER UGCAND IS AVAILABLE ON UGC WEBSITE

Student will prefer one from group one in sem (V)and One from Group TWO in sem (VI).

#THEORY AND PRACTICAL EXAMINATION WILL BE CONDUCTED BY COLLEGE

Prin..Dr.S.B.Dharap( Chairman BOS chemistry MU)

**AC 31/08/2015**
**Item No. 4.23**

T. Y. B. Sc. Syllabus for Inorganic chemistry practicals.

Sem-V

1. Preparations:

I) Chromium(II) acetate.

II) Cu(Ox)(H2O)2

III) Prussian Blue

IV) Zn(NH3)4.I2

2. Experiments with Models.

3. Determination of Composition of a mixture of a mixture of strong and weak acid by titration with a strong base using a suitable indicator.

Sem-VI

1. Preparations

I) Vanadium(Iv) (AcAc)2

II) Cu(HgI4)

III) Hg(Co(SCN)4)

IV) Cu(NH3)4.Cl2

2. Identification of crystals by using compound microscopes.

3. Redox titrations.