



**JANARDAN BHAGAT SHIKSHAN PRASARAK
SANSTHA'S**

**CHANGU KANA THAKUR
ARTS, COMMERCE & SCIENCE COLLEGE,
NEW PANVEL (AUTONOMOUS)**

**Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai**

Program: B.Sc

**Revised Syllabus of F.Y.B.Sc. Chemistry
Choice Based Credit System CBCS (75:25)
w.e.f. Academic Year 2019-20**

Sr. No.	Heading	Particulars
1	Title of Course	Chemistry
2	Eligibility for Admission	12 th Science of all recognised Board
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (75:25)
8	Status	Revised
9	To be implemented from Academic year	2019-2020

Name of BOS Chairperson:

Dr. S.K. Patil

Date: 12/04/2019

Signature:

Draft of the proposed syllabus for CBCS

PREAMBLE OF THE SYLLABUS:

Bachelor of Science (B.Sc.) in Chemistry is an undergraduate course of Department of Chemistry, Changu Kana Thakur Arts, Commerce & Science College, New Panvel (Autonomous). The Choice Based Credit System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students at first year of the B.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also to expose the students and to develop interest in them in various fields of Chemistry.

The new and updated syllabus is based on disciplinary approach with vigour and depth taking care of the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop understanding of various aspects of the chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledge are among such important aspects.

OBJECTIVES OF THE COURSE:

1. To promote understanding of basic facts and concepts in Chemistry while retaining the excitement of Chemistry.
2. To make students capable of studying Chemistry in academic and Industrial courses.
3. To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
4. To develop problem solving skills in students.
5. To acquaint students with the fundamental Organic, Inorganic, Physical & Analytical Chemistry.
 - To develop analytical skills and critical thinking through application of theory knowledge into practical course.
 - To construct and apply knowledge of chemistry, and appreciate the relationship between Chemistry and other disciplines.
 - To enable students to understand Chemistry and its Industrial and Social Context.

COURSE OUTCOME: BY THE END OF THE COURSE, A STUDENT SHOULD DEVELOP THE ABILITY:

- To understand, coherently and effectively about various genres of Chemistry.
- To develop the understanding and interest in the field of Chemistry
- To develop basic skills in practical Chemistry and its industrial applications.

F. Y. B. SC. CHEMISTRY

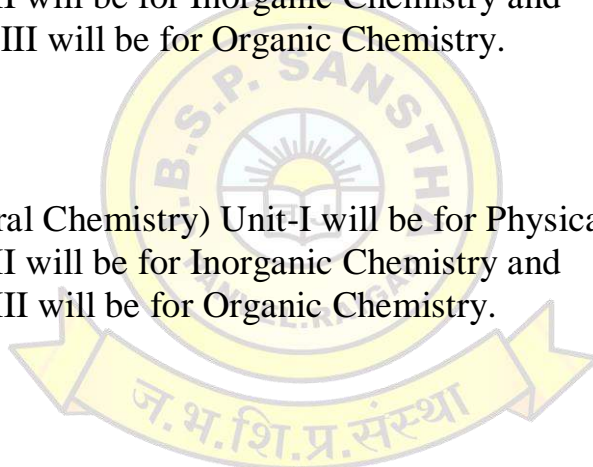
For the subject of Chemistry there shall be two papers for 45 lectures each comprising of three units of 15 L each.

SEMESTER-I

1. Paper-I / II (General Chemistry) Unit-I will be for Physical Chemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry and
3. Paper- I / II Unit-III will be for Organic Chemistry.

SEMESTER-II

1. Paper-I /II (General Chemistry) Unit-I will be for Physical Chemistry
2. Paper-I / II Unit-II will be for Inorganic Chemistry and
3. Paper-I / II Unit-III will be for Organic Chemistry.



SCHEME OF EXAMINATION FOR EACH SEMESTER:

Internal Evaluation: 25 (20 marks internal test and 05 marks for attendance)

Semester End Examination: 75 Marks will be as follows -:

I	Theory:	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q-1	From Unit – I (having internal options.) 20 M
	Q-2	From Unit – II (having internal options.) 20M
	Q-3	From Unit – III (having internal options.) 20M
	Q-4	Questions from all the THREE Units with equal weightage of marks Allotted to each Unit. 15 M
II	Practical	The External examination per practical course will be conducted as per the Following scheme.
Sr. No.	Particulars of External Practical Examination	Marks%
1	Laboratory Work	35+35 =70
2	Journal	5+5 = 10
3	Viva	10+10 = 20
	TOTAL	100

Choice Based Credit System (CBCS)
F.Y.B. Sc. Chemistry Syllabus
To be implemented from the Academic year 2019-2020
SEMESTER I

Course Code	Unit	Topics	Credits	L / Week
USC1CH1	I	Chemical Thermodynamics Chemical Calculations.	2	1
	II	Atomic structure, Periodic Table and periodicity Solid State Chemistry		1
	III	Classification and Nomenclature of Organic Compounds Bonding and Structure of organic Compounds Fundamentals of organic reaction Mechanism		1
USC1CH2	I	Chemical Kinetics Liquid state	2	1
	II	Comparative chemistry of Main Group Elements Catalysis Concept of hybridization		1
	III	Stereochemistry I		1
USC1PR1		Chemistry Practical	2	6

Choice Based Credit System (CBCGS)
F.Y.B. Sc. Chemistry Syllabus
To be implemented from the Academic year 2019-2020
SEMESTER II

Course Code	Unit	Topics	Credits	L / Week
USC2CH1	I	Gaseous state Chemical Equilibrium and Thermodynamic parameters	2	1
	II	Concept of Qualitative Analysis, Acid Base Theories		1
	III	Chemistry of Aliphatic Hydrocarbons		1
USC2CH2	I	Ionic equilibria, Molecular Spectroscopy Solid State Chemistry	2	1
	II	Chemical bond and Reactivity Oxidation Reduction Chemistry		1
	III	Aromatic hydrocarbons		1
USC2PR2		Chemistry Practical	2	6

Semester I
Paper I
Unit-I

1.1 Chemical Thermodynamics: (10L)

Thermodynamic terms: System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zeroth law of thermodynamics First law of thermodynamics: concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected) Thermochemistry: Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation (Numericals expected)

1.2 Chemical Calculations: (5L)

Expressing concentration of solutions: Normality, molality, molarity, formality, mole fractions, weight ratio, volume ratio, weight to volume ratio, ppm, ppb, millimoles, milliequivalents (Numericals expected)

Unit II

2.1 Atomic structure: (10L)

(Qualitative treatment only; it is expected that the learner knows the mathematical statements and understands their physical significance after completing this topic. No derivations of the mathematical equations required)

- a) Historical perspectives of the atomic structure; Rutherford's Atomic Model, Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Structure of hydrogen atom.
- b) Hydrogenic atoms:
 1. Simple principles of quantum mechanics;
 2. Atomic orbitals
 - i) Hydrogenic energy levels
 - ii) Shells, subshells and orbitals
 - iii) Electron spin
 - iv) Radial shapes of orbitals
 - v) Radial distribution function
 - vi) Angular shapes of orbitals.
 3. Many Electron Atoms
 - i) Penetration and shielding
 - ii) Effective nuclear charge
 4. Aufbau principle

2.2: Periodic Table and periodicity: (5L)

Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements; Periodicity in the following properties: Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule); electronegativity; Pauling, Mulliken and Alred Rochow electronegativities (Numerical problems expected, wherever applicable.)

Unit III

3. Basics of Organic Chemistry

3.1 Classification and Nomenclature of Organic Compounds: (5L)

Review of basic rules of IUPAC nomenclature. Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds: alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues.

3.2 Bonding and Structure of organic compounds: (4L)

Hybridization: sp^3 , sp^2 , sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide) Overlap of atomic orbitals: Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. Shapes of molecules; Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne)

3.3 Fundamentals of organic reaction mechanism: (6L)

Electronic Effects: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strengths.

Bond fission: Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles; Nucleophilicity and basicity;

Types (primary, secondary, tertiary, allyl, benzyl), shape and their relative stability of reactive intermediates: Carbocations, Carbanions and Free radicals.

Introduction to types of organic reactions: Addition, Elimination and Substitution reaction. (With one example of each)

Semester I

Paper II

Unit I

1.1 Chemical Kinetics: (8L)

Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected) Determination of order of reaction by (a)

Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected)

1.2 Liquid State: (7L)

Surface tension: Introduction, methods of determination of surface tension by drop number method (Numericals expected) Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected) Refractive index: Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer (Numericals expected) Liquid crystals: Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals.

Unit-II

2.0 Comparative chemistry of Main Group Elements: (15L)

Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship. Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. Some important compounds- NaHCO_3 , Na_2CO_3 , NaCl , NaOH , CaO , CaCO_3 ; oxides of carbon, oxides and oxyacids of sulphur and nitrogen with respect to environmental aspects.

Unit III

3. Stereochemistry I: (15L)

Classification of isomer, IUPAC nomenclature of stereoisomers. Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions; Geometrical isomerism in alkene and cycloalkanes: 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 similar and dissimilar chiral-centres, Distereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations. Conformation analysis of alkanes (ethane, propane and n-butane); Relative stability with energy diagrams.

Semester II Paper I Unit-I

1.1 Gaseous State: (8L)

Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected)

Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule-Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected)

1.2 Chemical Equilibria and Thermodynamic Parameters: (7L)

Reversible and irreversible reactions, law of mass action, dynamic equilibria, equilibrium constant, (K_c and K_p), relationship between K_c and K_p , Le Chatelier's principle, factors affecting chemical equilibrium (Numericals expected)

Statement of second law of thermodynamics, concepts of entropy and free energy, spontaneity and physical significance of free energy, thermodynamic derivation of equilibrium constant (Numericals expected)

Unit II

2.1 Concept of Qualitative Analysis: (4L)

Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.)

2.2 Coordination chemistry (3L)

- 1) Introduction to coordination compound
- 2) Terminology in coordination compound
- 3) Types of ligands

2.2 Acid Base Theories: (8L)

Arrhenius, Lowry- Bronsted, Lewis, Lux-Flood acid –base concept, Usanovich acid –base concept, Solvent – Solute concept of acids and bases, Hard and Soft acids and bases. Applications of HSAB

Applications of acid base chemistry in:

- i) Volumetric analysis with special reference to calculation of titration curve involving strong acid and strong base.

Unit III

3. Chemistry of Aliphatic Hydrocarbons

3.1 Carbon-Carbon sigma bonds: (3L)

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

3.2 Carbon-Carbon pi bonds: (12L)

Formation of alkenes and alkynes by elimination reactions: Mechanism of E1, E2,

E1cb reactions. Saytzeff and Hofmann eliminations.

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 using N-bromosuccinimide and mechanism, e.g. propene, 1-butene, toluene, ethylbenzene.

Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Semester II

Paper II

Unit I

1.1 Ionic Equilibria: (7L)

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 acid (exact treatment for monoprotic acid)

Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected)

1.2 Molecular Spectroscopy: (4L)

Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, fluorescence, electronic, vibrational and rotational transitions, Beer-Lambert's law (Numericals expected)

1.3 Solid State Chemistry (4L)

Types of solids, crystal lattice, lattice points, unit cell, space lattice and lattice plane, laws of crystallography: Law of constancy of interfacial angle, law of symmetry and law of rational indices (Numericals expected)

Unit II

2.1: Chemical Bond and Reactivity: (7L)

Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for AB_n type molecules with and without lone pair of electrons, isoelectronic principles, applications and limitations of VSEPR theory.

2.2: Oxidation Reduction Chemistry: (8L)

- a) Reduction potentials
- b) Redox potentials: half reactions; balancing redox equations.
- c) Redox stability in water
- i) Latimer and Frost Diagrams
- ii) pH dependence of redox potentials.
- d) Applications of redox chemistry
- i) Extraction of elements: (example: isolation of copper by auto reduction)
- ii) Redox reagents in Volumetric analysis: a) I₂; b) KMnO₄

Unit III

3.2 Aromatic Hydrocarbons: (15L)

Aromaticity: Hückel's rule anti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism. Hammond's postulate, directing effects of The groups. Disadvantages of F&C acylation and alkylation reaction. Name reaction Involving Electrophilic aromatic substitution.

Reference Books:

1. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University Press (2014).
2. Ball D.W., Physical Chemistry, Thomson Press, India (2007).
3. Castellan G.W., Physical Chemistry, 4th Ed., Narosa (2004).
4. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
5. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson (2013).
6. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press (2014).
7. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt. Ltd., New Delhi (2004).
8. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
9. Metz C.R., 2000 Solved Problems in Chemistry, Schaum Series (2006).
10. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
11. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).
12. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000).

Unit II

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.

Unit III

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

CHEMISTRY PRACTICALS:

Semester I

Unit I: Physical Chemistry

1. To prepare 0.1 N succinic acid and standardize the NaOH of two different Concentrations
2. To determine the rate constant for the hydrolysis of ester using HCl as catalyst
3. To determine enthalpy of dissolution of salt (like KNO_3)
4. To find refractive index of the given liquid samples (Benzene, Nitrobenzene, aniline, Ethanol) and find molar refraction and specific refraction.

Unit II: Inorganic Chemistry

1. Commercial analysis of
 - a) Mineral acid
 - b) Organic acid
2. Titration using double indicator: analysis of solution of Na_2CO_3 and NaHCO_3 .
3. Gravimetric analysis
 - a) To determine the percent purity of sample of BaSO_4 containing NH_4Cl
 - b) To determine the percent purity of ZnO containing ZnCO_3 .

Unit III: Organic Chemistry

Purification of Organic Compound compounds by

1. Recrystallization (02) (Benzoic acid, Acetanilide)
2. Sublimation (01) Phthalic anhydride to Phthalic acid
3. Distillation. (01)

(Recording of M.P. & B.P.)

Learners are expected to report

- a) Solvent for recrystallization. (Recrystallization)
- b) Mass and the M.P. & B.P. of purified compound.

Learners should calibrate thermometer before determining melting point.

2. Chromatography

- b) Separation of a mixture of o-and p-nitrophenols by thin layer chromatography (TLC)

CHEMISTRY PRACTICALS:

Semester II

Unit I: Physical Chemistry

1. To determine the rate constant for the saponification reaction between ethyl acetate and NaOH
2. To determine dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pHmetrically.
3. To verify Beer-Lambert's law, using KMnO₄ solution by colorimetric method.
4. To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.

Unit II: Inorganic Chemistry

1. Qualitative analysis: (at least 4 mixtures to be analyzed)

Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions.

Cations (from amongst):

Ba²⁺, Ca²⁺, Sr²⁺, Cu²⁺, Cd²⁺, Fe²⁺, Ni²⁺, Mn²⁺, Mg²⁺, Al³⁺, Cr³⁺, K⁺, NH₄⁺

Anions (From amongst): CO₃²⁻, S²⁻, SO₃²⁻, NO₂⁻, NO₃⁻,

Cl⁻, Br⁻, I⁻, SO₄²⁻, PO₄³⁻.

(Scheme of analysis should avoid use of sulphide ion in any form for Precipitation / separation of cations.)

2. Redox Titration: To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration)

Unit III: Organic Chemistry

Characterization of monofunctional organic compound (solid, liquid) containing C, H, (O), N, S, X elements. (minimum 6 compounds)

Characteristic Reactions of following Test

- 1) Test for unsaturation (KMnO_4 and bromine water)
 - 2) Test for acid 3) Test for phenol
 - 4) Test for base 5) Test for nitrogen
 - 6) Test for sulphur 7) Test for halogens
 - 8) Functional groups test
- A) Alcohols
 - B) Aldehyde and ketone
 - C) Esters
 - D) Primary aromatic amines
 - E) Nitro/Dinitro
 - F) Phenol
 - G) Amide

Reference Books

Unit I: Physical Chemistry

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001).

Unit II: Inorganic Chemistry

Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

Unit III: Organic Chemistry

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

Item No. _____

UNIVERSITY OF MUMBAI**Syllabus for Approval**

Sr. No.	Heading	Particulars
1	Title of Course	S. Y. B. Sc. Chemistry
2	Eligibility for Admission	F. Y. B. Sc. Passed from this autonomous college or university of mumbai (or with ATKT in any three courses at the F. Y. B. Sc. Level) or equivalent qualification from other universities as may have been allowed by the relevant ordinances of this autonomous college or university of mumbai
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic year	2020-2021

Date : 20-6-2021

Dr.S.K.Patil
BOS Chairperson:
Vice Principal & Head
Department of Chemistry

Signature:
Prin. Dr. Bahrate V.D.

UNIVERSITY OF MUMBAI

Essentials Elements of The Syllabus

1	Title of Course	Syllabus for two semester S. Y. B. Sc. course in chemistry
2	Couse Code	USCH301, USCH302, USCH303 USCH401, USCH402, USCH404 USCHP1 to USCHP6
3	Preamble	Attached
4	Objective	<ul style="list-style-type: none">• To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.• To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course.• To make the learner capable of solving problems in the various units of this course• To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry• To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling• To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
5	Eligibility	Pass F. Y. B. Sc.
6	Fee Structure	As Per Guidelines issued from the autonomous college or university of Mumbai
7	No. of Lectures	9 lectures per week (three lectures per paper)
8	No. of Practicals	9 periods per week (three periods per paper)
9	Duration of Course	Two Semester

10	Notional Hours	72 hours per paper per semester Theory and 36 hours per paper per semester for laboratory sessions
11	No of students per batch	120 students per division (20 Students for laboratory sessions)
12	Selection	As per merit.
13	Assessment	End of semester examination of 75 marks per paper for theory and 50 marks per paper for laboratory sessions
14	Syllabus Detail	Attached
15	Title of the Unit	As given in the Syllabus text
16	Title of the Sub-unit	As given in the syllabus text.
17	Semester wise Theory	As prescribed in the syllabus text
18	Semester wise Practicals	As prescribed in the syllabus text.
19	Question Paper Pattern	As prescribed by the Faculty of Science
20	Scheme of evaluation of Project	N.A.
21	List of suggested reading	As Attached
22	List of websites	As Attached
23	List of You Tube videos	As attached
24	List of MOOCs	As Attached

Examination;

Semester	Paper Numbers	Semester	Theory (min. Passing marks)	Internal Test- 20M Overall conduct 5M (min. Passing marks)	Practicals (min. Passing marks)	Passing Standard
III	I, II, III	III	75 marks (30M) Each paper	25 Marks (10M) Each paper	50 M Each Paper Total =150M (60M)	40% each Head Separate for Theory & pract.
IV	I, II, III	IV	75 marks (30M) Each paper	25 Marks (10m) Each paper	50 M Each Paper Total =150M (60m)	40% each Head Separate for Theory & pract.

Question Papers Pattern:

Theory : 75Marks

All questions are compulsory :

Question : 1) 15marks; Includes;

- a) Multiple choice questions or fill in the blanks (9 out of 12) with a) , b),l)**
- b) True or False (3 out of Six) with i) , ii), iii), iv) v), vi)**
- c) Match the following (3 out of Six); a) , b), c), d), e), f) against i) , ii), iii), iv) v), vi)**

Question : 2), 3) and 4) 20 marks each;

Each sub questions should have 5 marks each (4 out of 6) with nos : A), B),....F)

REGULATIONS

1. Preamble and objectives of the Course :

In the first two semesters of the six semester graduation program of B. Sc.(Chemistry) the learner was introduced to some basic aspects in the various core branches of chemistry like Physical Chemistry, Organic chemistry and Inorganic chemistry. Concepts about the structure of atom, distribution of electrons, Thermodynamics, Formation of organic compounds and basic ideas in reactivity of molecules in general and organic compounds in particular were introduced to the learner. He was made inquisitive about why and how should atoms combine to give molecules or ions. The non-orbital approach to appreciating the shapes of polyatomic species in general and molecules in particular.

The story of chemistry is taken further in the coming two semesters of the second year of the B. Sc. (Chemistry) Program. However it is also realised that some students opting for the course on Chemistry may not continue with the subject subsequently as such the syllabus is designed to retain the interest of the serious learner of chemistry as well as be helpful to non-chemistry learners. With such students who would want to pursue other branches of science but would want to acquire a basic appreciation and experience of chemistry a separate paper (Paper-III) is designed. This paper along with the laboratory session unit that goes with it deals with the basics of chemical analysis, separating components from a given sample, basic concepts like pH, experimental techniques like Titrimetry, Gravimetry, using instruments to carry out analysis, the various techniques like chromatography, electrophoresis, Instrumentation in general is felt to be of interest to learners of various branches like physics, botany, zoology, and microbiology.

The major objectives of B.Sc. Chemistry course are

- To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry.

- To make the learner proficient in analysing the various observations and chemical phenomena presented to him during the course.
- To make the learner capable of solving problems in the various units of this course
- To give the learner an opportunity to get hands on experience of the various concepts and processes in the various branches of chemistry
- To impart various skills of handling chemicals, reagents, apparatus, instruments and the care and safety aspects involved in such handling
- To make the learner capable of analysing and interpreting results of the experiments he conducts or performs
- To make the learner capable of acquiring or pursuing a source of livelihood like jobs in chemical industry
- To arouse the interest to pursue higher levels of learning in chemistry,

2. Condition for Admission

A candidate who has passed the F.Y.B.Sc. of Mumbai University or an examination of some other university accepted by the syndicate as equivalent there to with Chemistry, Physics, Maths, Botany, Zoology or Life Science shall be eligible for admission into S.Y.B.Sc., course in Chemistry.

To

3. Duration of the Course: one year

4. Course of study:

**Draft of the proposed revised syllabus for Choice
Based Credit System
S.Y.B.Sc. Chemistry
To be implemented from the Academic year 2020-2021**

For the subject of chemistry there shall be three papers for 45 lectures each comprising of three units of 15 L each.

Semester-III

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
Unit-II Inorganic Chemistry
Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
Unit-II Inorganic Chemistry
Unit-III Organic Chemistry.
3. Paper III Basics of Analytical Chemistry
Unit-I Introduction to Analytical Chemistry and Statistical Treatment of analytical data-
Unit-II Classical Methods of Analysis
Unit-III Instrumental Methods-I

Semester-IV

1. Paper-I (General Chemistry) Unit-I Physical Chemistry
Unit-II Inorganic Chemistry
Unit-III Organic Chemistry.
2. Paper-II (General Chemistry) Unit-I Physical Chemistry
Unit-II Inorganic Chemistry
Unit-III Organic Chemistry.
Basics of Analytical Chemistry
4. Paper III Basics of Analytical Chemistry
Unit-I Separation Techniques in Analytical Chemistry -
Unit-II Instrumental Methods-II
Unit-III Statistical Treatment of analytical data --II

Choice Based Credit System
S. Y. B. Sc.
Chemistry Syllabus
To be implemented from the Academic year 2020-2021

Course Content
Semester III

Course Code	Unit	Topics	Credits	L/Week
USCH301	I	Chemical Thermodynamics-II, Electrochemistry	2	1
	II	Chemical Bonding		1
	III	Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides		1
USCH302	I	Chemical Kinetics-II, Solutions	2	1
	II	Selected topics on p block elements		1
	III	Carbonyl Compounds		1
USCH303	I	Intorduction to Analytical Chemistry and Statistical Treatment of analytical data-I	2	1
	II	Classical Methods of Analysis.		1
	III	Instrumental Methods-I		1
USCHP1	Chemistry Practicals I		1	3
USCHP2	Chemistry Practicals II		1	3
USCHP3	Chemistry Practicals III		1	3

Semester IV

Course Code	Unit	Topics	Credits	L/Week
USCH401	I	Electrochemistry-II, Phase Equilibria	2	1
	II	Comparative Chemistry of the transition metals & Coordination Chemistry		1
	III	Carboxylic acids and their derivatives, Sulphonic acids		1
USCH402	I	Solid state, Catalysis	2	1
	II	Ions in aqueous medium & Uses and Environmental Chemistry of volatile Oxides and oxo-acids		1
	III	Amines, Diazonium salts, Heterocyclic compounds		1
USCH403	I	Separation Techniques in Analytical Chemistry	2	1
	II	Instrumental Methods-II		1
	III	Statistical Treatment of analytical data --II		1
USCHP4	Chemistry Practicals I		1	3
USCHP5	Chemistry Practicals II		1	3
USCHP6	Chemistry Practicals III		1	3

Semester III
Paper I
Theory: 45 Lectures

Unit I: Physical Chemistry

1.1 Chemical Thermodynamics-II(8L)

1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's

free energy with Pressure and Temperature.

1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore.

(Numericals expected).

1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation.

1.1.4 Concept of Fugacity and Activity

1.2 Electrochemistry: (7L)

1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.

1.2.2 Kohlrausch law of independent migration of ions.

1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected).

1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.

Unit-II

Chemical Bonding

2.1 Non-Directional Bonding (4L)

2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond.

2.1.2 Types of Ionic Crystals

2.1.3 Radius Ratio Rules

2.1.4 Lattice Energy, Born-Landé Equation

2.1.5 Kapustinski Equation

2.1.6 Born-Haber Cycle and its Application

2.2. Directional Bonding: Orbital Approach. (6L)

2.2.1 Covalent Bonding The Valence Bond Theory- Introduction and basic tenets.

- 2.2.2 Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system.
- 2.2.3 Homonuclear diatomic molecules from He₂ to Ne₂
- 2.2.4 Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.
- 2.2.5 Bonding in Polyatomic Species: The role of Hybridization. And types of hybrid orbitals-*sp*, *sp*², *sp*³, *sp*³*d*, *sp*²*d*² and *sp*²*d* *sp*³*d*².
- 2.2.6 Equivalent and Non-Equivalent hybrid orbitals
- 2.2.7 Contribution of a given atomic orbital to the hybrid orbitals (with reference to *sp*³ hybridisation as in CH₄, NH₃ and H₂O and series like NH₃, PH₃, AsH₃, BiH₃)

2.3 Molecular Orbital Theory (5L)

- 2.3.1. Comparing Atomic Orbitals and Molecular Orbitals.
- 2.3.2. Linear combination of atomic orbitals. to give molecular orbitals LCAO-MO approach for diatomic homonuclear molecules).
- 2.3.3 Molecular orbital Theory and Bond Order and magnetic property: with reference to O₂, O₂⁺, O₂⁻, O₂²⁻

(Problems and numerical problems expected wherever possible)

Unit III: Organic Chemistry

3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]

- 3.1.1. **Alkyl halides:** Nucleophilic substitution reactions: S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group.
- 3.1.2. **Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S_NAr) addition-elimination mechanism and benzyne mechanism.
- 3.1.3. **Organomagnesium and organolithium compounds: [3L]**
Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO₂, cyanides and epoxides.

3.2 Alcohols, phenols and epoxides: [8L]

- 3.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols
- 3.2.2. **Phenols:** Preparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols.
- 3.2.3. **Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.

Semester III Paper II

Unit I: Physical Chemistry

1.1 Chemical Kinetics-II (7L)

1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected),

Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected).

1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (E_a). (Numericals expected).

1.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only)

1.2 Solutions: (8 L)

1.2.1 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.

1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water, Triethanolamine – Water and Nicotine – Water systems

1.2.3 Immiscibility of liquids- Principle of steam distillation.

1.2.4 Nernst distribution law and its applications, solvent extraction.

Unit-II

2. Selected topics on p block elements

(15L)

2.1 Chemistry of Boron compounds

- 2.1.1 Electron deficient compounds – BH_3 , BF_3 , BCl_3 with respect to Lewis acidity and applications.
- 2.1.2 Preparation of simple boranes like diborane and tetraborane.
- 2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds)
- 2.1.4 Synthesis of Borax.

2.2 Chemistry of Silicon and Germanium

- 2.2.1 Silicon compounds: Occurrence, Structure and inertness of SiO_2
- 2.2.2 Preparation of structure of SiCl_4
- 2.2.3 Occurrence and extraction of Germanium
- 2.2.4 Preparation of extra pure Silicon and Germanium

2.3 Chemistry of Nitrogen family

- 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen.
- 2.3.2 Oxides of nitrogen with respect to preparation and structure of NO , NO_2 , N_2O and N_2O_4 .
- 2.3.3 Synthesis of ammonia by Bosch – Haber process.

Unit III: Organic Chemistry

Carbonyl Compounds: [15L]

- 31 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes
- 32 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.
- 33 Reactions of aldehydes and ketones with NaHSO_3 , HCN , RMgX , alcohol, amine, , 2,4-Dinitrophenyl hydrazine, LiAlH_4 and NaBH_4 .
- 34 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, and Cannizzaro reaction.
- 35 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization
- 36 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols.

3.7 Stereochemistry: (5 L)

Regioselective, chemoselective, stereoselective and stereospecific reactions.

Stereochemistry of: i) Substitution reaction (SN^1 , SN^2 and SN^1)

ii) Addition reaction (catalytic hydrogenation) (5L)

Semester III
Paper III
Basics in analytical Chemistry

1. Introduction to Analytical Chemistry (15 L)

1.1 Introduction (6L)

1.1.1 General introduction of analytical chemistry

1.1.2 Chemical Analysis: Qualitative and Quantitative analysis. Common Analytical Problems, Important terms associated with chemical analysis, Steps in chemical analysis, Purpose of chemical analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)

1.1.3 Classification of analytical methods (Classical & instrumental methods)

Importance of analytical chemistry in various fields (Pharmaceutical, Clinical, agriculture, environmental studies and research).

1.2 Errors in Analysis (3L)

1.2.1 Concepts of Accuracy and Precision: terms,

1.2.2 Types of Errors: Determinate and Indeterminate error

1.2.3 Expression of error: Absolute and Relative Error & Constant and proportionate error

1.2.4 Minimization of Determinate error

1.3 Interpretation of Results of Analysis (6L)

1.3.1 Concept of true and acceptable value

1.3.2 Measures of central tendency: Mean, median, mode

1.3.3 Measures of Dispersion: Absolute Deviation, Relative Deviation, Relative average deviation, standard deviation, variance, coefficient of variation.

1.4 Significant Figure

(Problems including Numericals expected)

2. Classical methods of Analysis –I (15L)

2.1 Titrimetric Analysis -I(1L)

2.1.1 Terms involved in Titrimetric Analysis

2.1.2 Types of Titrations

2.2 Tools of titrimetry: Graduated glassware and their Calibration (3L)

i) Volumetric Flask

ii) Burette

iii) Pipette

2.3 Standardization (4L)

2.3.1 Introduction, Concept of standard solution, primary standard, secondary standard

2.3.2 Requirements for primary and secondary standard

2.3.3 Preparation of standard solutions: (Molarity, Formality Normality W/W W/V, ppm) dilution of solution. (Numerical Problems expected)

2.4 Neutralization Titrations (6L)

2.4.1. Concept of pH and its importance in Neutralisation Titrations

2.4.2 End point and Equivalence point of Neutralisation titrations

2.4.3 Construction of titration curve (on the basis of change in pH) and choice of indicator of a titration of

i. Strong acid-strong base

ii. Strong acid-weak base

iii. Strong base-weak acid

2.4.4 Theory of Acid base indicators; Illustrate Acid base indicators with examples (1L)

3. Basic Concepts in Instrumental methods (15L)

- 3.1 Relation between the Analyte, Stimulus and measurement of change in the observable property.
- 3.2 Block Diagram of an Analytical instrument.
- 3.3 Types of Analytical Instrumental methods based on
 - i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
 - ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
 - iii. Thermal interactions (eg. Thermogravimetry) (3L)
- 3.4. Absorption Spectroscopy(12 L)
 - 3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy
 - 3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbitivity
 - 3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer - Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)
(Numerical problems based on Beer-Lambert's Law)
 - 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters
 - 3.4.5. Block Diagrams for Single beam and double beam Colorimeter
 - 3.4.6. quantitative applications of colorimetry: Calibration curve method.

Semester IV
Paper I

Unit I: Physical Chemistry

1.1 Electrochemistry-II: (8 L)

- 1.1.1 Electrochemical conventions, Reversible and irreversible cells.
- 1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected).
- 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG , ΔH and ΔS from EMF data. (Numericals expected)
- 1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected)
- 1.1.5 Concentration cells with transference and without transference. Liquid junction potential and salt bridge.
- 1.1.6 pH determination using hydrogen electrode and quinhydrone electrode. (Numericals expected)

1.2 Phase Equilibria: (7L)

- 1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation.
- 1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (numericals expected)
- 1.2.3 Phase diagrams of one-component systems (water and sulphur).

- 1.2.4 Two component systems involving eutectics, congruent and incongruent melting points (lead-silver system).

Unit-II

2.1 Comparative Chemistry of the transition metals (9 L)

- 2.1.1** Position in the periodic table; Natural occurrence principal ores and minerals;
- 2.1.2** Significance of special stability of d^0 , d^5 and d^{10} leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)

- 2.1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer).
- 2.1.4 Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments.
- 2.1.5 Chemistry of Titanium and vanadium: properties of Oxides and chlorides; use in titrimetric analysis
- 2.1.6 Qualitative tests for transition metal ions: General considerations in devising tests (with reference to Chromium, Manganese, iron, Cobalt Nickel and Copper)

2.2 Coordination Chemistry : (6 L)

2.2.1 Introduction to Chemistry of Coordination Compounds

- i. Isomerism :General Types with special reference to stereoisomerism of coordination compounds (C.N=6)
- ii. Evidence for the formation of coordination compounds,

2.2.2. Theories of coordination compounds

- i. Effective atomic number rule.
- ii. Eighteen electron Rule

2.2.3. Nature of the Metal-Ligand Bond:

- i. Valence Bond Theory; Hybridisation of the central metal orbitals- sp^3 , sd^3/d^3s sp^3d^2/d^2sp^3 , sp^2d ,
- ii. Inner and outer orbital complexes of .(suitable examples of Mn(II) Fe(II),Fe(III),Co(II)/Co(III),Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used)
- iii. Limitations of V.B.T

2.2.4. Application of coordination compounds.

Unit III: Organic Chemistry

3.1 Carboxylic Acids and their Derivatives :(11 Lectures)

- 3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids.

3.12 Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles.

3.13 Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with LiAlH_4 , diborane, Hell-Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity.

3.14 Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.

3.15 Mechanism of Claisen condensation and Dieckmann condensation.

3.2 Stereochemistry (4L) Stability of cycloalkane: Strain in cycloalkanes, angle, eclipsing, trans annular (3 to 6membered). Conformations of cyclohexane, mono and di-alkyl cyclohexane and their relative stability.(4L)

Semester IV Paper II

Unit I: Physical Chemistry

1.1 Solid State: (7L)

1.1.1 Recapitulation of laws of crystallography and types of crystals

1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected)

1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)

1.2 Catalysis: (8 L)

1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation

1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH.

1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation)

1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.

Unit-II

2 Ions in aqueous medium

2.1. Acidity of Cations and Basicity of Anions

- i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius.
- ii. Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation
- iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples
- iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions- concept, diagram classification on the basis of basicity

2.2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids

- i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid
- ii. Uses and environments aspects of these acids

Unit III: Organic Chemistry

Nitrogen containing compounds and heterocyclic compounds:

3.1 Amines: Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines;

3.1.1. Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation, chemical reduction using Fe-HCl, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination, Hofmann bromamide reaction.

3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM), Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation.

3.2 Diazonium Salts: (7 Lectures)

Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg reaction, Replacement of diazo group by -H, -OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine

3.3 Heterocyclic Compounds: (8 Lectures)

- 3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom;
- 3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis),
- 3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution.
- 3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine.
- 3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).

Semester IV

Paper III

Basics in analytical Chemistry

1. Methods of Separation in Analytical Chemistry (15L)

1.1 An Introduction to Analytical Separations and its importance in analysis. (2L)

1.2 Estimation of an analyte without effecting separation.

1.3 Types of separation methods

1.3.1 Based on Solubilities (Precipitation, Filtration Crystallisation)

1.3.2 Based on Gravity- Centrifugation

1.3.3 Based on volatility-Distillation ;

1.3.4 Based on Electrical effects-Electrophoresis

1.3.5 Based on retention capacity of a Stationary Phase -Chromatography;

1.3.6 Based on distribution in two immiscible phases-Solvent Extraction;

1.3.7 Based on capacity to exchange with a resin-Ion Exchange;

1.4 Chromatography:(2L)

1.4.1 Introduction to Chromatography

1.4.2 Classification of chromatographic methods based on stationary and mobile phase

1.5 Planar Chromatography (7L)

Principle, techniques and applications of

1.5.1 Paper chromatography

1.5.2 Thin layer chromatography

1.6 Electrophoresis (4L)

Introduction, Principle and theory of electrophoresis, Different types of electrophoresis techniques, Moving Boundary Electrophoresis, Zone electrophoresis- Paper, Cellulose acetate and Gel electrophoresis, Applications of electrophoresis

2. Instrumental Methods – II (15L)

Instrumental techniques based on the electrochemical properties of the analytes

2.1 Potentiometry: (5 L)

2.1.1 Principle. Selection of indicator electrode system for various types of titrimetric reaction Acid base titrations

2.1.2. Role of Reference and indicator electrodes

2.1.3. Applications, advantages and limitations

2.1.4. detection of equivalence points Graphically

2.2. pHmetry: (4 L)

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis.

2.3. Conductometry(6 L)

2.3.1. Principle

2.3.2. Conductivity cell its construction and care

2.3.3. conductometric titration curves for following titrations

i. Strong Acid-Strong Base

ii. Strong Acid-Weak Base

iii. Strong Base-weak Acid

iv. Weak Acid- Weak Base.

2.3.4. Advantages & limitations of conductometric titrations.

3. A] Classical Methods of Analysis -II (10L)

3.1. Titrimetric Analysis-II

3.2. Precipitation Titration (4L)

3.1.1. Argentimetric titration

3.1.2 Construction of titration curve(numerical problems expected)

3.2.3 Selecting and evaluating the end point: Volhard method, Mohr's method, using adsorption indicator

3.2 Gravimetric Analysis (6 L)

3.2.1. General Introduction to Gravimetry.

3.2.2. Types of Gravimetric Methods

3.2.3 Steps involved in gravimetry analysis

3.2.4 Isolation of ion of interest

3.2.5. Precipitation: Nucleation (homogeneous and herogeneous)& crystal growth, Super solubility curve, significance of metastable region

i. Factors affecting precipitation: Common ion effect and solubility product

ii. Colloidal precipitates (coagulation of colloids, peptization of colloids, treatment of colloidal precipitates). Crystalline precipitates (particle size and filterability).

iii. Conditions for precipitation

iv. Completion of precipitation,

v. Role of Digestion, Filtration, Washing : Choice of washing liquid, Drying Ignition of precipitate.

3.2.6 Co-precipitation (surface adsorption, mixed-crystal formation, occlusion, and mechanical entrapment, co precipitation errors).

B] Introduction to environmental analysis (5 L)

3.3.1 Environmental pollution from industrial effluents.

i. sources and types of pollutants

ii. Causes and consequences

- iii. Role of EPA and central pollution control board.
- 3.3.2 Analysis of soil: Composition of soil, Sampling of soil, Industrial effluents and their interactions with soil components.
 - i. Determination of pH of soil samples.
 - ii. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.
- 3.3.3 Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.
 - i. Physical Parameters: Colour, Temperature, Taste and Odour, Turbidity, Conductivity, Hydrogen Ion Concentration (pH), Total Solids, Suspended and Dissolved Solids.
 - ii. Chemical Parameters: Acidity, Alkalinity, Hardness, Chlorides, Fluorides, Dissolved Oxygen,
 - iii. Determination of pH, acidity and alkalinity of a water sample.
 - iv. Determination of dissolved oxygen (DO) of a water sample.

(Semester 4 is not having any numerical based unit; however semester 3 is having all 3 units with numericals)

Semester III Chemistry Practicals:

Unit I: Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
4. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
5. To determine solubility of sparingly soluble salts (anytwo) conductometrically.

Unit II: Inorganic Chemistry

1. 1) Identification of two cations and two anions in a given mixture containing following: cations Pb^{2+} (II), Ba^{2+} (II), Ca^{2+} (II), Sr^{2+} (II), Cu^{2+} (II), Cd^{2+} (II), Mg^{2+} (II), Zn^{2+} (II), Fe^{2+} (II), Fe^{3+} (III), Ni^{2+} (II), Co^{2+} (II) Al^{3+} (III), Cr^{3+} (III)] and Anions : Cl^- , Br^- , I^- , NO_3^- , SO_4^{2-} , and CO_3^{2-}
2. Crystallisation of potassium iodate and to estimate its purity before and after the separation.
3. Estimation of total hardness
4. Investigation of the reaction between Copper sulfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

Unit III: Organic Chemistry

Short organic preparation and their purification: Use 0.5-1.0g of the organic compound.

Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product.

Preparation of:

1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose
3. Tribromoaniline from aniline.
4. β -Naphthylbenzoate
5. m-Dinitrobenzene from nitrobenzene

6. Phthalic anhydride from phthalic acid by sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

(Any eight preparations)

Semester IV Chemistry Practicals:

Unit I: Physical Chemistry

1. To determine standard EMF and the standard free energy change of Daniel cell potentiometrically .
2. To determine the amount of HCl in the given sample potentiometrically.
3. Compare the strengths of HCl and H₂SO₄ by studying kinetics of acid hydrolysis of methyl acetate.
6. Industrial visit report.

Unit II: Inorganic Chemistry

1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.
2. Complex cation – *Tris* (ethylene diamine) nickel (II) thiosulphate.
3. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium) and a large anion hexanitrocobaltate(III) and its use to precipitate a large cation (potassium)

Unit III: Organic Chemistry

Qualitative Analysis of bi-functional organic compounds on the basis of

- 1. Preliminary examination**
- 2. Solubility profile**
- 3. Detection of elements C, H, (O), N, S, X.**
- 4. Detection of functional groups**
- 5. Determination of physical constants (M.P/B.P)**

Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides, amines, alkyl and aryl halides.

Students are expected to write balanced chemical reactions wherever necessary.
(Minimum 6 compounds to be analyzed)

Reference Books for Practicals:

Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry, 8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996

Reference Books:

Unit I:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., New York (1985).
6. K.L.Kapoor A textbook of Physical Chemistry 3rd Ed. vol.1,2 Macmillan Publishing Co., New Delhi (2001)

Unit II:

1. *Practical Inorganic Chemistry* by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
3. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
4. Vogel's Textbook of quantitative chemical analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar

5. References.

6. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
7. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
8. Chemistry of Transition Elements Pg.- 608 – 679 .
9. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.
10. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999) page 325-446.
11. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
12. CNR Rao edited, University General Chemistry, 513-578.
13. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,
14. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry, page no. 435-463.
15. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
16. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt., Ltd. (2002).
17. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry, page 416-628.
18. Bruce H. Mahan, University Chemistry, Narosa publishing house.
19. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
20. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS
21. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
22. Ramesh Kapoor and R.S. Chopra, Inorganic Chemistry, R. Chand publishers, New Delhi.
23. CNR Rao edited, University General Chemistry
24. James E. Huheey, Inorganic Chemistry: Principles of Structure and Reactivity,

25. Emeleus and Anderson, Modern Aspects of Inorganic Chemistry
26. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
27. Gary Wulfsberg, Inorganic chemistry, Viva Books Pvt., Ltd. (2002).
28. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry

Unit III:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
5. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
6. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
7. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds, Derek barton ,W. David Ollis.
8. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
9. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994.
10. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Semester III Paper

III

Basics in analytical Chemistry

Theory: 45 Lectures

The Role of Analytical chemistry in various fields including non-chemistry fields such as Environmental Science, Pharmacy, Medicine, Life Sciences, Petrochemicals, Arts (like Painting) Forensic sciences and so on can never be underestimated. This course is expected to introduce the learner to this interesting field of Analytical Chemistry.

It is expected to provide the learner an overview of this very important branch of chemistry. After successful completion of this course the learner is expected to be familiar with the question of what is analysis, why it is required and the methods, techniques, procedures and protocols that may be used or required in the course of a given problem of analysis. The learner is also expected to appreciate the role of an Analytical Chemist and a Chemical Analyst.

Correctness or acceptability of the results of a given analysis and how to deal with wrong or erroneous results: when to reject them and when and how to retain them to be meaningful and/or acceptable are some other attributes expected as outcomes of learning this paper.

As such it is felt that this paper will be a subject of choice and interest for learners preferring a specialisation in Chemistry as well as to those who may have interests in other science fields as Physics, Botany, Zoology, Microbiology, Geochemistry and so on.

Goal:

To introduce the learner to an area of learning that is vital for the inherent nature of the subject itself but also is important and irreplaceable irrespective of the long term interest of specialisation or subject of interest of the learner.

**Unit I- Introduction to Analytical Chemistry and Statistical Treatment
of analytical data-I (15 L)**

Scope/ Objectives:

Learners should be able to

1. Select a method of analysis
2. Decide how to identify a sample and prepare it for analysis
3. Select a procedure for analysis
4. Identify sources of possible errors in the results obtained.

(Problems including numericals expected wherever necessary)

1.1. Role of Analytical Chemistry (9 L)

- 1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry.
- 1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis)
- 1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance.

1.2. Significance of Sampling in Analytical Chemistry

- 1.2.1. Terms involved in Sampling
- 1.2.2. Types of Sampling
- 1.2.3. Sampling techniques

1.3. Results of Analysis. (6L)

- 1.3.1. Errors in Analysis and their types
- 1.3.2. Precision and Accuracy in Analysis
- 1.3.3. Corrections for Determinate Errors

(Problems including Numericals expected wherever required)

References:

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch
2. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, 7th Edition
3. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch

4. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

Unit II- Classical Methods of Analysis(15 L)

Objectives:

The main objectives of this unit is to

- Introduce classical methods of chemical analysis.
- Appreciate the various terms and types of titrimetric analysis.
- Ability to select proper titrimetric method
- Appreciate the usefulness of the gravimetric method of analysis
- Identify a suitable gravimetric method
- Perform the required calculations involved in the analysis by titrimetry as well as gravimetry.

2. Classical Methods of Analysis. (04L)

21. Titrimetric Methods

- 2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry
- 2.1.2. The Conditions suitable for titrimetry
- 2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox, (Iodometry, Iodimetry,) Precipitation and Complexometric titrations and indicators used in these titrations
- 2.1.4. Tools of Titrimetry: Graduated glasswares and Calibration

22. Standard solutions (Primary and Secondary standards in Titrimetry) and Calculations in Titrimetry.

23. Neutralisation Titrations (04L)

- 2.3.1. Concept of pH and its importance in Neutralisation Titrations
- 2.3.2. End point and Equivalence point of Neutralisation titrations
- 2.3.3. Determination of End point by using
 - i. Indicators causing colour change
 - ii. Change in potential, (by potentiometry)
 - iii. Change in conductance (by conductometry)
- 2.3.4. Construction of titration curve (on the basis of change in pH)of a titration of
 - i. Strong acid-weak base
 - ii. Strong base-weak acid

24. Gravimetric analysis (06 L)

- 2.4.1. General Introduction to Gravimetry.
- 2.4.2. Types of Gravimetric Methods –
- 2.4.3. Precipitation Gravimetry:
 - i. Steps involved in precipitation gravimetry analysis
 - ii. Conditions for precipitation
 - iii. Completion of precipitation,
 - iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate.

- v. Applications of Gravimetric Analysis: Determination of sulfur in organic compounds; Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime; Determination of Aluminum by converting it to its oxide.

References:

- 1) Skoog et al. "Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15
- 2) Day and Underwood, "Quantitative analysis" prentice hall 1991, chapter 3
- 3) S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition NewAge International Publisher
- 4) Gary D. Christan, "Analytical Chemistry", VIth Edition, Wiley Students Edition, Chapter No 8,9,10
- 5) Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
- 6) Modern Analytical Chemistry, David Harvey (page numbers 232 -265)

Unit III: Instrumental Methods-I [15 L]

Objectives:

On completing the learning of this unit the learner is expected to

- Know the various instrumental methods of analysis
- Advantages of using instruments to make measurements
- The various observable properties of a given analyte and the stimulus best suited for its analysis
- Know about a generalized diagram of an analytical instrument
- Select a suitable instrumental method for analysis
- Appreciate the basic terms in spectrometry
- Use the relationship between absorbance (and its variations) and concentration of the analyte.
- Chose a suitable method for photometric titrations.

3. Basic Concepts in Instrumental methods (03)

31. Relation between the Analyte, Stimulus and measurement of change in the observable property.
32. Block Diagram of an Analytical instrument.
33. Types of Analytical Instrumental methods based on
 - i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)
 - ii. Electrochemical interactions (eg. Potentiometry, Conductometry,)
 - iii. Thermal interactions (eg. Thermogravimetry)

34 Spectrometry (07 L)

- 3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy
- 3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic

light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorbivity

- 3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer-Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law ((Real deviations, Instrumental deviations and Chemical deviations)
(Numerical problems based on Beer-Lambert's Law)
- 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers
- 3.4.5. Block Diagrams for Single beam and Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e , source ,Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube)
- 3.4.6. Applications of UV-Visible Spectrophotometry (02 L)**
(a) Qualitative analysis such as Identification of functional groups in Organic compounds ,Chromophores and Auxochrome,*cis* and *trans* isomers
(b) Quantitative analysis by Calibration curve method and
- 3.4.7. Photometric Titrations: Principle ,Instrumentation, Types of Photometric titration Curves with examples. (03L)**

References:

1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K. Anand pp 2.107-2.148
2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp 143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp 118-181.

Semester III Chemistry
Practicals: Paper III
Basics in Analytical Chemistry

1. Tools of Analytical Chemistry-I:

- a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.
- b) Weighing tools such as two pan balance and monopan balance, digital balances:
- c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
- d) Drying Devices: Hot Air Oven, Microwave Oven, Descicators, Vacuum descicators
- e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes

(The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal.

2. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error.
(The learner is expected to know the role of the various reagents/chemicals used In the estimation, various steps involved. They should write the complete and Balanced chemical reaction for the formation of the Ni(DMG)₂ complex.
3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error.
(The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve and compare it with the calculated slope. They are also expected to state the error estimate of their results).
4. Determination of buffer capacity of acid buffer and basic buffer.
(The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity)
5. Estimation of Aspirin
6. Gravimetric estimation of barium ions using K₂CrO₄ as precipitant calculation of % error.
(The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation; Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)

Semester IV

Paper III Basics in Analytical Chemistry -II

Theory: 45 Lectures

Unit –I -Methods of separation (15 L)

Objectives:

The learner is expected to understand

- The importance of separation in sample treatment
- Various methods of separations
- How to select a method of separation of an analyte from the matrix
- How a solute gets distributed between two immiscible phases
- Principle of solvent extraction and various terms involved therein
- Effect of various parameters on solvent extraction of a solute
- Classification of Chromatographic methods
- Paper and thin layer chromatography and using them in practice.

1. Separation Techniques in Analytical Chemistry

(02 L)

- 1.1. An Introduction to Analytical Separations and its importance in analysis.
- 1.2. Estimation of an analyte without effecting separation.
- 1.3. Types of separation methods
 - 1.3.1. Based on Solubilities (Precipitation, Filtration Crystallisation)
 - 1.3.2. Based on Gravity- Centrifugation
 - 1.3.3. Based on volatility-Distillation ;

- 1.3.4. Based on Electrical effects-Electrophoresis
- 1.3.5. Based on retention capacity of a Stationary Phase -Chromatography;
- 1.3.6. Based on distribution in two immiscible phases-Solvent Extraction;
- 1.3.7. Based on capacity to exchange with a resin-Ion Exchange;
- 1.4. Electrophoresis:** Principles, Basic Instrumentation, Working and Application in separation of biomolecules like enzymes and DNA. (02L)

1.5. Solvent extraction (06 L)

- 1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient.
- 1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH.
- 1.5.3. Single step and multi step extraction, Percentage extraction for single step and multistep extraction. Separation factor.
- 1.5.4. Batch and continuous extraction

1.6. Chromatography : (05L)

- 1.6.1. Introduction to Chromatography
- 1.6.2. Classification of chromatographic methods based on stationary and mobile phase
- 1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations.
- 1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; Following progress of a given reaction .

References :

1. D.A. Skoog, D.M. West, F.J. Holler and CX.R. Crouch – Fundamentals of Analytical chemistry, 8th edition
2. G.H. Morrison and H. Freiser , Solvent extraction in analytical chemistry
3. P. G. Swell and B. Clarke, Chromatographic separations , Analytical chemistry by open Learning , John Wiley and sons, 1987
4. Modern Analytical Chemistry , David Harvey (page numbers 596 -606)
5. Modern Analytical Chemistry , David Harvey (page numbers 215 -217)

Unit –II - Instrumental Methods-II (15 L)

Objectives

On completing this unit the learner is

- Expected to appreciate the nature of interaction between applied electrical potential and the concentration of the analyte.
- The nature of chemical reactions that influence potential of a given cell.
- Familiar with the various types of electrodes or half cells.
- Appreciate the nature, need and importance of pH
- Expected to know the applications of the various instrumental methods dealt with in this unit.

2. Instruments based on the electrochemical properties of the analytes

2.1. Potentiometry: (05 L)

2.1.1. Principle.

2.1.2. Role of Reference and indicator electrodes

2.1.3. Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode)

2.1.4. Graphical methods for detection of end points

2.2. pHmetry: (04 L)

2.2.1. Principle

2.2.2. Types of pH meters.

2.2.3. Principle, Construction Working and Care of Combined Glass electrode

2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis.

2.3. Conductometry: (06 L)

2.3.1. Principle

2.3.2. Conductivity cell its construction and care

2.3.3. Applications in Neutralisation Titrimetry with respect to

i. Strong Acid-Strong Base

ii. Strong Acid-Weak Base

iii. Strong Base-weak Acid

iv. Weak Acid- Weak Base.

2.3.4. Advantages & limitations of conductometric titrations.

References:

- 1) Principles of Instrumental analysis, D. A. Skoog, 3rd edition, Saunders college publishing. Chapters: 20, 23 Page nos: 600 - 605, 631, 704 - 711.
- 2) Vogel's Text book of quantitative inorganic analysis, 4th edition, ELBS/ Longman. Chapters: XIV, XV Page nos: 566 - 601, 615 - 625.
- 3) Instrumental methods of analysis, B. K. Sharma, Goel publishing house. Miscellaneous methods: Chapters: 1, 3, 4 Page nos: 1 - 14, 21 - 57.

Unit III- Statistical Treatment of analytical data --II (15 L)

Objectives:

On completing this unit the learner is expected to understand

- i) The use of statistical methods in chemical analysis.
- ii) The nature of indeterminate errors
- iii) The randomness of such errors and its distribution around a correct or acceptable result
- iv) Computation of Confidence limits and confidence interval
- v) Test for rejection of doubtful result
- vi) Method to draw best fitting straight line

3.1.Nature of Indeterminate Errors: (03L)

3.1.1. The true and acceptable value of a result of analysis

3.1.2. Measures of central tendency: mean, median, mode, average

3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation, (s, sigma) variance, coefficient of variation

3.2. Distribution of random errors: (02L)

3.2.1. Gaussian distribution curve.

3.2.2. Equation and salient features of Gaussian distribution curve

3.3. Concept of Confidence limits and confidence interval and its computation using (03 L)

(i) Population standard deviation

(ii) Student's t test

(iii) Range

3.4. Criteria for rejection of doubtful result (02 L)

(i) 2.5 d rule

(ii) 4.0 d rule

(iii) Q test

3.5. Test of Significance (02 L)

(i) Null hypothesis

(ii) F-test (variance ratio test)

3.6. Graphical representation of data and obtaining best fitting straight line (03 L)

(a) For line passing through origin

(b) For line not passing through origin

[Numerical problems wherever possible, expected]

References:

1. Modern Analytical Chemistry, David Harvey (page numbers 53 -84)
2. Fundamentals of analytical chemistry – Skoog and West

Semester IV Chemistry Practicals:

Paper III Elective

(Basics in analytical Chemistry)

1. Tools of Analytical Chemistry-II
 - a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.
 - b. Development chamber for chromatography
 - c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)
 - d. Conductivity cell (with respect to care and maintenance.)
 - e. Combined Glass electrode (with respect to care and maintenance.)
 - f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in (a and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2. **Paper chromatography:** Separation of cations like Fe(III), Ni(II) and Cu(II) in a sample.

3. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions.

(The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)

4. Conductometric titration: Estimation of given acid by conductometric titration with strong base and calculation of % error. (The learner is expected to learn the handling of the conductometer and the conductivity cell, determination of end point by plotting a graph. They are also expected to state the error estimate of their results).
5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine end point by plotting a graph. They are also expected to state the error estimate of their results).
6. Gravimetric estimation of Sulfate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)
(The learner is expected to write a balanced chemical reaction, need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.)

REFERENCES:

For paper III

1. **D. A. Skoog, D. M. West, F. J. Holler, and S. R. Crouch, Analytical Chemistry: An Introduction, 7th ed., Chapter 15, pp. 345-381.**
2. **A.I. Vogel. "Textbook of Quantitative Inorganic Analysis," Longman, London (1961).**
3. **R.V. Dilts. "Analytical Chemistry. Methods of Separation," van Nostrand, N.Y. (1974).**
4. **Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B.BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi**

AC 27/2/13
Item No. 4.20

UNIVERSITY OF MUMBAI



Syllabus for sem V & VI

Program: B.Sc.

Course: CHEMISTRY

(Credit Based Semester and Grading System with
effect from the academic year 2013–2014)

**T.Y.B.Sc.
CHEMISTRY
Credit Based Semester and Grading System
To be implemented from the Academic year 2013-2014**

**SEMESTER V
Theory**

Course	UNIT	TOPICS	Credits	L / Week
USCH501	I	<p>1.1 Colligative Properties of Dilute Solutions (8L) 1.1.1 Dilute solution, colligate properties, Raoult's law, relative lowering of vapour pressure. 1.1.2 Elevation in boiling point of a solution, thermodynamic derivation relating elevation in the boiling point of a solution and the molar mass of the non-volatile solute. 1.1.3 Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and the molar mass of the non-volatile solute. 1.1.4 Osmotic pressure, van't Hoff's equation for osmotic pressure, (derivation is expected) and determination of molar mass of the solute. Abnormal molar masses of solutes and van't Hoff factor (calculation of Degree of Association and Degree of Dissociation.) 1.2 Phase Rule (7L) 1.2.1 Gibb's phase rule and terms involved in the equation. 1.2.2 Application of phase rule to ONE component systems (i) water system, (ii) sulphur system 1.2.3 Application of phase rule to TWO component systems, condensed systems, condensed phase rule, eutectic systems (Lead-Silver system), desilverisation of lead. 1.2.4 Introduction to three component system, explanation of phase diagram for three liquids forming one immiscible pair.</p>	2.5	1

	II	<p>2.1 Surface Chemistry & Catalysis (9L)</p> <p>2.1.1 Adsorption: Physical and Chemical Adsorption, types of adsorption isotherms . Langmuir’s adsorption isotherm (Postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected). significance of the terms involved in the equation is expected.),determination of surface area of an adsorbent using B.E.T. equation. Numericals on surface area determination are expected.</p> <p>2.1.2 Catalysis: Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation,</p> <p>2.1.3 Acid-Base catalysis, mechanism and kinetics of acid-base catalyzed reactions, effect of pH on acid-base catalyzed reactions. Mechanism and kinetics of enzyme catalyzed reaction (Michaelis-Menten equation).</p> <p>2.2 Colloids (6L)</p> <p>2.2.1 Introduction to colloidal state of matter.</p> <p>2.2.2 Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern model, Electro-kinetic phenomena: 1.Electrophoresis ,2.Electrophoresis ,3. Streaming potential 4. Sedimentation potential .</p> <p>2.2.3 Colloidal electrolytes.</p> <p>2.2.4 Donnan Membrane Equilibrium.</p> <p>2.2.5 Surfactants, micelle formation, applications of surfactants in detergents, food industry, in pesticide formulations.</p>		1
	III	<p>3.1 Electrochemistry – Electrochemical cells (15L)</p> <p>3.1.1 Lewis concept of Activity and Activity coefficient, Mean ionic activity and mean ionic activity coefficient γ_{\pm} of an electrolyte, expression for activities of electrolytes of different valence type, ionic strength of a solution, Debye-Huckel limiting law (derivation not expected)</p>		1

	<p>3.1.2 Classification of cells: 1.chemical cells without transference 2.Concentration cells with and without transference (derivations of expression for concentration cell EMF are expected) Origin of liquid-liquid junction potential and its elimination using a salt bridge.</p> <p>3.1.3 Applications of EMF .measurements in the determination of 1. pH of a solution using quinhydrone and glass electrode. 2 solubility and solubility product of sparingly soluble salts using chemical cell and concentration cell method 3. determination of liquid-liquid junction potential .</p>		
IV	<p>4.1 Introduction to Polymers (8L) 4.1.1 Basic terms : macromolecule, monomer, repeat unit, degree of polymerization. 4.1.2. Classification of polymers based on (i) source, (ii) structure, (iii) thermal response, (iv) physical properties. 4.1.3. Molar masses of polymers: 1. Number average molar mass, 2.Weight average molar mass, 3. Viscosity average molar mass, monodispersity, polydispersity. 4.1.4. Methods of determining molar masses of polymers : 1. Ultracentrifuge method (Limiting velocity method only). Viscosity method (Mark-Houwink equation). 4.1.5. Introduction to light emitting polymers (characteristics, method of preparation and it's application are expected). 4.2 Crystalline State (7L) 4.2.1. Laws of Crystallography 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). 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 and KCl,</p>		1

		determination of Avagadro number. 4.2.4. Elementary idea of defects in crystals- Frenkel defect and Schottky defect.		
USCH502	I	<p>1. Chemical Bonding And Solid State Chemistry (15L)</p> <p>1.1 Molecular Symmetry (10L)</p> <p>1.1.1 Introduction and Importance.</p> <p>1.1.2 Symmetry elements and symmetry operations.</p> <p>1.1.3 Concept of a Point Group with illustrations using the following point groups: (i) $C_{\infty v}$ (HCl), (ii) $D_{\infty h}$ (H_2), (iii) C_{2v} (H_2O), (iv) C_{3v} (NH_3), (v) C_{2h} (trans – trichloroethylene), and (vi) D_{3h} (BCl_3).</p> <p>1.2 Molecular Orbital Theory for Polyatomic Species (5L)</p> <p>1.2.1 Simple triatomic species: H_3^+ and H_3 (correlation between bond angle and Molecular orbitals).</p> <p>1.2.2 Other molecules (considering only σ-bonding): i) BeH_2, ii) H_2O,</p>	2.5	1

	II	<p>2. Solid Materials (15L) 2.1 Structures of Solids (10L) 2.1.1 Importance of solid state chemistry. 2.1.2 Classification of solids on the basis of bonding. 2.1.3 Explanation of terms viz. crystal lattice, lattice points, unit cells and lattice constants. 2.1.4 Closest packing of rigid spheres (hcp, ccp), packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected). 2.1.5 Structure metallic solids. 2.1.6 Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes, limiting radius ratios for different coordination numbers and their significance, calculation of limiting radius ratio for coordination number 4. 2.1.7 Structures of sodium chloride and cesium chloride. 2.2 Superconductivity (05L) 2.2.1 Superconductivity, Meissner effect. 2.2.2 Different superconducting materials viz, conventional superconductors, organic superconductors, alkali metal fullerenes (A_3C_{60}) and high temperature Superconductors. 2.2.3 Applications of superconducting materials.</p>		1
	III	<p>3. Chemistry of elements (15L) 3.1 Inner transition elements (3L) 3.1.1 Introduction: position of f-block elements and comparison between lanthanides and actinides 3.1.2 The shapes of <i>f</i>-orbitals. 3.1 Lanthanides Series (10L) 3.2.1 Chemistry of lanthanides with reference to (i) lanthanide contraction, (ii) Oxidation states (iii) magnetic and spectral properties, 3.2.2 Occurrence, extraction and separation of lanthanides by Solvent extraction. 3.2.3 Applications of lanthanides.</p>		1

		<p>3.3 Actinides Series (2L) 3.3.1 Chemistry of Uranium and with reference to occurrence, extraction (solvent extraction method), 3.3.2 Properties and applications.</p>		
	IV	<p>4. Solution Chemistry 4.1 Acid-base Chemistry in Aqueous Medium (8L) 4.1.1 Acidity of mono- and polyatomic cations. 4.1.2 Basicity of mono- and polyatomic anions (discussion for 4.1.1 as well as 4.1.2 to Include Latimer equation and predominance diagrams). 4.2 Chemistry in Non-aqueous Solvents (7L) 4.2.1 Classification of solvents and importance of non-aqueous solvents. 4.2.2 Characteristics and study of liquid ammonia, dinitrogen tetraoxide and acetic acid as non-aqueous solvents with respect to (i) acid-base reactions and (ii) redox reactions.</p>		1
USCH503	I	<p>1.1. Mechanism of Organic Reactions (15L) 1.1.1 Thermodynamic and Kinetic control of organic reactions: Concept with mechanisms of the following reactions: addition of HX to butadiene; sulfonation of naphthalene. Nucleophilicity/ electrophilicity vs Basicity/acidity. 1.1.2 Mechanism of elimination reactions, with stereochemistry: E1 and E2 reactions: regioselectivity (Saytzeff and Hofmann rules). 1.1.3 Mechanism of reactions of carbonyl compounds with nucleophiles: 1.1.3.1 Formation of acetals/ketals from aldehydes and ketones. 1.1.3.2 Reaction of aldehydes and ketones with primary and secondary amines. 1.1.3.3 Acyl nucleophilic substitution (tetrahedral mechanism): Acid catalysed esterification of Carboxylic acids and base promoted hydrolysis of esters. 1.1.4 Mechanism of rearrangements with examples and stereochemistry wherever applicable. 1.1.4.1 Migration to electron deficient carbon: Pinacol,</p>	2.5	1

		<p>Benzylic acid. 1.1.4.2 Migration to electron deficient nitrogen: Beckmann, Hofmann.</p> <p>1.1.5 Mechanism of the following reacts with synthetic application: Claisen condensation, Michael addition.</p>	
	II	<p>2. Stereochemistry (15L)</p> <p>2.1.1 Molecular chirality and element of symmetry: Mirror Plane symmetry (inversion centre), rotation-reflection (alternating) axis, Chirality of compounds without stereogenic centre: cummulenes, spirans and biphenyls.</p> <p>2.1.2 Stability of cycloalkanes: Strains in cycloalkanes-angle, eclipsing, transannular (3 to 8 membered). Conformations of cyclohexane, mono- and di- alkyl cyclohexanes and their relative stabilities.</p> <p>2.1.3 Stereo selectivity and Stereo specificity: Idea of enantioselectivity (ee) and diastereoselectivity (de). Topicity-enantiotopic and diastereotopic atoms, groups and faces.</p> <p>Stereochemistry of-</p> <p>(1) Substitution reactions- S_N1, S_N2, S_Ni (reaction of alcohol with thionyl chloride). (2) E_2-anti-elimination-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 (molecular addition) with OsO_4 and $KMnO_4$.</p>	1
	III	<p>3.1 Carbohydrates (10L)</p> <p>3.1.1 Introduction: Classification, Sources, Reducing and non-reducing sugars DL notation.</p> <p>3.1.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides and Haworth formula-Furanose and pyranose forms of pentoses and hexoses. Interconversion :open and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with stereochemistry of D-glucose and D-fructose. Stability of chair forms of D-</p>	1

		<p>glucose.</p> <p>3.1.3 Determination of open chain configuration- of D-glucose assuming the configuration of D-arabinose; and of D-fructose assuming the configuration of D-glucose.</p> <p>3.1.4 Anomers and epimers of monosaccharides. Enantiomers and diastereomers of glucose. Mutarotation (with mechanism) in D-glucose.</p> <p>3.1.5 Chain lengthening and shortening reaction: Modified kiliani-fischer synthesis. Wohl method.</p> <p>3.1.6 Reactions of D-glucose and D-fructose: (a) osazone formation (b) reduction- H_2/Ni, $NaBH_4$ c)oxidation- bromine water, HNO_3, HIO_4. D) interconversion of D-glucose and D-fructose e) acetylation f) methylation [e and f with cyclic pyranose form].</p> <p>3.1.7 Commercial importance of carbohydrates in pharmaceutical, paper, food and Textile industries.</p> <p>3.2. IUPAC Nomenclature (5L) IUPAC systematic and accepted trivial nomenclature of the following classes of compounds, including substituted ones (up to 2 substituents/ functional groups):</p> <p>3.2.1 (a) Bicyclic compounds- spiro-, fused, and bridged (upto 11 carbon atoms)-saturated and unsaturated compounds.</p> <p>3.2.2 (b) Biphenyls.</p> <p>3.2.3 (c) Cummulenes upto 3 double bonds (d) Monocyclic (5 and 6 membered) aromatic and non-aromatic heterocyclic compounds containing a maximum of two hetero atoms among N,O,S.</p> <p>3.1.1 Introduction: Classification, Sources, Reducing and non-reducing sugars DL notation.</p> <p>3.1.2 Structures of monosaccharides: Fischer projection (4-6 carbon monosaccharides and Haworth formula-Furanose and pyranose forms of pentoses and hexoses. Interconversion :open and Haworth forms of monosaccharides with 5 and 6 carbons. Chair conformation with</p>		
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	<p>IV</p>	<p>4.1. Heterocyclic Chemistry (8L)</p> <p>4.1.1 Introduction: Electronic structure and aromaticity of furan, pyrrole, thiophene and pyridine.</p> <p>4.1.2 Synthesis: Synthesis of furans, pyrroles, and thiophenes by Paal-Knor synthesis. Pyridines by Hantzsch synthesis and from 1,5-diketones.</p> <p>4.1.3 Reactivity: Reactivity towards electrophilic substitution reactions- of furan, pyrrole and thiophene on basis</p>		<p>1</p>

of stability of intermediate; and of pyridine on the basis of electron distribution. Nucleophilic substitution reaction of pyridine on the basis of electron distribution.

4.1.4 Reactions of heterocycles: The following reactions of furan, pyrrole and thiophene: Halogenation, Nitration, Sulphonation, Vilsmeier formylation reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction. Ring opening of furan. Pyrrole: Acidity and basicity of pyrrole-Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine, with and without catalyst. Reduction. Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction). N-methylation of pyridine. Quaternization of piperidine, pyrrolidine and Hofmann elimination of the quaternary salts.

4.2. Organic Synthesis (7L)

4.2.1 Introduction: Criteria for ideal organic synthesis. Yield and selectivity. Multi-component synthesis – with examples, Mannich reaction, Hantzsch synthesis of pyridines (without mechanism).

4.2.2 Illustrative synthesis of industrially important compounds: Ibuprofen (chiral synthesis), paracetamol (green synthesis), L-ascorbic acid (from D-glucose), norfloxacin, thyroxine, vanillin, methyl dihydrojasmonate (Hedione), Bifenox-I, pigment red 242, indigo, 2-hydroxy-3-amino-5-nitrobenzene sulphonic acid.

4.2.3 Newer methods of organic synthesis: Introduction to the use of the following in organic synthesis: Ultrasound, microwaves, PTC.

4.1.1 Introduction: aromaticity of furan, pyrrole, thiophene and pyridine.

4.1.2 Synthesis: Synthesis of furans, pyrroles, and thiophenes by Paal-Knorr synthesis. Pyridines by Hantzsch

synthesis and from 1,5-diketones. **4.1.3**

Reactivity: Reactivity towards electrophilic substitution reactions- of furan, pyrrole and thiophene on basis of stability of intermediate; and of pyridine on the basis of electron distribution. Nucleophilic substitution reaction of pyridine on the basis of electron distribution.

4.1.4 Reactions of heterocycles: The following reactions of furan, pyrrole and thiophene: Vilsmeier formylation reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction. Ring opening of furan. Pyrrole: Acidity and basicity of pyrrole-Comparison of basicity of pyrrole and pyrrolidine, Acid catalyzed polymerization of pyrrole. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine, with and without catalyst. Reduction. Oxidation of alkyl pyridines and action of sodamide (Chichibabin reaction). N-methylation of pyridine. Quaternization of piperidine, pyrrolidine and Hofmann elimination of the quaternary salts.

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4.2.3 Newer methods of organic synthesis: Introduction to the use of the following in organic synthesis: Ultrasound, microwaves, PTC.

USCH504	I	<p>1. Treatment of analytical data-I and sampling (15 L)</p> <p>1.1 Treatment of Analytical Data (7L) Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors, accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation.[Numerical problems expected]</p> <p>1.2 Sampling (8L) Terms involved, importance of sampling, sampling techniques, sampling of gases, ambient and stack sampling, equipment used, sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids, methods and equipments used, sampling of solids, importance of particle size and sample size, samples used, need for the reduction in the sample size, methods of reduction in sample size, collection, preservation and dissolution of the sample.</p>	2.5	1
	II	<p>2. Titrimetric analysis-I and UV-Visible spectroscopy. (15L)</p> <p>2.1 Acid-base Titrations (5L) Construction of titration curves and choice of indicators in the titration of [1] strong acid and strong base, [2] strong acid and weak base, [3] weak acid and strong base, [4] weak acid and weak base.</p> <p>2.2 Precipitation titrations (4L) Argentometric titrations, construction of the titration curve, Volhard's method, Mohr's method, adsorption indicators, theory and applications.</p> <p>2.3 U.V. Visible Spectroscopy (4L) Photometers and spectrophotometers, Instrumentation in the case of single and double beam spectrophotometers, Qualitative and quantitative analysis, calibration curve method.</p>		1

	<p style="text-align: center;">III</p>	<p>3. Methods of separation-I (15L) 3.1 Solvent Extraction (8L) Partition coefficient and distribution ratio, extraction efficiency, separation factor, role of complexing agents in solvent extraction, chelation, ion pair formation, solvation, types of solvent extraction: batch, continuous. [Numerical problems expected] 3.2 Chromatography (2L) Introduction to chromatographic techniques, classification of chromatographic techniques. 3.3 Planar Chromatography (5L) Principle, techniques and applications of [1] Paper chromatography [2] Thin layer chromatography</p>		<p style="text-align: center;">1</p>
	<p style="text-align: center;">IV</p>	<p>4. Optical methods (15L) 4.1 Atomic Spectroscopy (7L) Absorption and emission spectra, energy level diagrams, process involved in atomization, flame photometry, flame atomizer, types of burners, monochromators and detectors, atomic absorption spectroscopy; flame and electrothermal atomizer, sources, instrumentation, quantitative applications of atomic absorption and flame photometry, calibration curve method, standard addition and internal standard method. 4.2 Molecular Fluorescence and Phosphorescence Spectroscopy (4L) Theory, instrumentation and applications 4.3 Turbidimetry and Nephelometry (4L) Scattering of light, effect of concentration, particle size and wavelength on light scattering, instrumentation and applications.</p>		<p style="text-align: center;">1</p>

Practicals

USCHP05	<p style="text-align: center;">Practicals of Course USCH501</p> <p><u>Physical Practical</u></p> <p>Chemical Kinetics – To determine the order between $K_2S_2O_8$ & KI by fractional change method.</p> <p>Viscosity – To determine the molecular weight of high polymer polyvinyl alcohol (PVA) by viscosity measurement.</p> <p style="text-align: center;">OR</p> <p>To determine the radius of a glycerol molecule by viscosity measurement.</p> <p>Potentiometry –</p> <ol style="list-style-type: none">1. 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+}2. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell. <p style="text-align: center;">OR</p> <ol style="list-style-type: none">3. To determine the solubility product and solubility of AgCl potentiometrically using concentration cell. <p>Colorimetry – To determine the amount of Fe(III) present in the given solution by using salicylic acid by colorimetric titration.(static method) ($\lambda=525$ nm)</p> <p>pH –Metry – To determine acidic and basic dissociation constants of amino acid hence to calculate isoelectric point.</p> <p>Course USCH502</p> <p><u>Inorganic Practical</u></p> <p>Inorganic preparations</p> <ol style="list-style-type: none">1. $Tris(en)_2 Ni(II)S_2O_3$2. Tetra-amminecopper (II)Sulphate3. $CuCl_2 \cdot 2DMSO$	3	8
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	<p>Inorganic estimation/analysis</p> <ol style="list-style-type: none"> 1. Ni complexometrically using Murexide indicator 2. Cu by iodometric method 		
USCHP06	<p>Practicals of Course USCH503</p> <p><u>Organic Practicals</u> Binary Mixture Separation & identification (Solid + Solid)</p> <p>Course USCH504</p> <p><u>Analytical Practicals</u></p> <ol style="list-style-type: none"> 1. Estimation of persulphate in the given sample by the method of back titration. 2. Determination of the calcium and the magnesium content of a dolomite sample. 3. Determination of glucose content of a honey sample by Wilstater's method. 4. Determination of the amount of fluoride in the given solution colorimetrically. 5. Determination of Vitamin C content of a given tablet by titration with sodium hydroxide pH metrically 	3	8

**T.Y.B.Sc.
Chemistry**
Credit Based Semester and Grading System
To be implemented from the Academic year 2013-2014

SEMESTER VI
Theory

Course	UNIT		Credits	L / Week
USCH601	I	<p>1.1 Molecular Spectroscopy -I</p> <p>1.1.1 Dipole moment: Dipole moment, polarization of a bond, bond moment, dipole moment and molecular structure.</p> <p>1.1.2 Rotational Spectrum: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, conditions for obtaining pure rotational spectrum, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift.</p> <p>1.1.3 Vibration (IR) 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.</p> <p>1.1.4 Vibration-Rotation spectrum of diatomic molecule vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches, anharmonic oscillator : energy levels, selection rule, fundamental band, overtones . Application of vibration-rotation spectrum in determining Force constant, determination and significance. Introduction to infrared spectra of simple molecules like H₂O and CO₂</p> <p>1.1.5 Raman Spectroscopy : Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum , Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman spectrum, comparative study of IR and Raman spectra, rule of mutual exclusion.(example of CO₂molecule).</p>	2.5	1
	II	<p>2.1 Basics of Quantum Chemistry (10L)</p> <p>2.1.1 Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton effect.</p> <p>2.1.2 Introduction to quantum mechanics,</p>		1

		<p>Planck's theory of quantization, wave particle duality, de-Broglie equation, Heisenberg's uncertainty principle.</p> <p>2.1.3 Progressive and standing waves, boundary conditions, Schrodinger's time independent wave equation(derivation not expected)., interpretation and properties of wave function.</p> <p>2.1.4 Postulates of quantum mechanics (following are to be considered), 1. state function and it's significance 2. 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 equation.</p> <p>2.2 Applied Electrochemistry (5L)</p> <p>2.2.1 Polarization, concentration polarization and it's elimination</p> <p>2.2.2 Decomposition potential, experimental determination of decomposition potential, factors affecting decomposition potential (nature of electrolyte, nature of electrodes and temperature) Tafel's equation for hydrogen overvoltage, Overvoltage, experimental determination of over-voltage, 2.2.3 Electroplating ---objectives and procedures</p>		
	<p>III</p>	<p>3.1 Renewable Energy Sources (5L)</p> <p>3.1.1. Lithium ion cell.</p> <p>3.1.2. Fuel cells; Choice of fuel and oxidant, Bacon's H₂ and O₂ fuel cell.</p> <p>3.1.3. Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters, silicon solar cell</p> <p>3.1.4. Hydrogen : Fuel of the future, production of hydrogen by direct electrolysis of water, advantages of hydrogen as a universal energy medium.</p> <p>3.2 Nuclear Magnetic Resonance Spectroscopy (6L)</p> <p>3.2.1. Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession, Relaxation processes in n.m.r. (spin-spin relaxation and spin-lattice relaxation).</p> <p>3.2.2. NMR Spectrometer, chemical shift, shielding and deshielding of protons, low resolution n.m.r. spectrum of methanol and ethanol.</p>		<p>1</p>

		<p>3.3 Chemical Kinetics (4 L)</p> <p>3.3.1 Collision theory of reaction rates, application of collision theory to 1. uni-molecular reaction and 2. bimolecular reaction (Lindemann theory, derivation expected). Merits and drawbacks of collision theory.</p> <p>3.3.2 Classification of reactions as slow, fast and ultra-fast. study of kinetics of fast reactions by Stop flow method.</p>		
	IV	<p>4.1 Nuclear Chemistry</p> <p>4.1.1 Types of nuclear radiations and their characteristics, behaviour of ion pairs in electric field, detection and measurement of nuclear radiations using G. M. Counter and Scintillation Counter.</p> <p>4.1.2 Kinetics of radioactive decay, units of radioactivity (Curie, Becquerel, Rutherford)</p> <p>4.1.3 Radioactive equilibrium (secular and transient), determination of radioactive constants for radio-elements having 1. moderate half life, 2. long half life 3. extremely long or short half life.</p> <p>4.1.4 Use of radioisotopes as tracers in 1. chemical investigations- reaction mechanism, 2. age determination- dating by carbon-14</p> <p>4.1.5 Nuclear reactions – nuclear transmutation, artificial radioactivity Q-value of nuclear reaction, threshold energy.</p> <p>4.1.6 Fissile and fertile material, nuclear fission, chain reaction, factor controlling fission process. (multiplication factor and critical size or mass of fissionable material), nuclear power reactor and breeder reactor.</p>		1
USCH602	I	<p>Coordination Chemistry (15L)</p> <p>1.1 Crystal Field Theory (CFT) (7L)</p> <p>1.1.1 Basic tenets of Crystal field theory and effect of crystal field on central metal valence orbitals.</p> <p>1.1.2 Splitting of <i>d</i> orbitals in octahedral, tetrahedral and square planar complexes.</p> <p>1.1.3 Crystal field splitting energy ($10\Delta_o/\Delta_o$) for octahedral complexes and factors affecting the magnitude of Δ_o.</p> <p>1.1.4 Crystal field stabilization energy (CFSE), calculation of CFSE, for octahedral and tetrahedral complexes with</p>	2.5	1

		<p>d^1 to d^{10} metal ion configurations.</p> <p>1.1.5 Effect of crystal field splitting on i) Ionic radius and ii) Lattice energy.</p> <p>1.1.6 Theoretical failure of the CFT model.</p> <p>1.1.7 Experimental evidence for covalence in co-ordination compounds. (i) ESR spectrum of $[\text{IrCl}_6]^{2-}$ (ii) NMR spectrum of tris (acetyl acetanato) vanadium complex, (iii) Intensities of $d-d$ transitions, and (iv) Nephelauxetic effect.</p> <p>1.2 Molecular Orbital Theory (MOT) of Coordination Complexes (4L)</p> <p>1.2.1 Application to octahedral complexes in case of (i) $[\text{Ti}(\text{H}_2\text{O})]^{3+}$, (ii) Fluoro complexes of Fe(II) and Fe (III) and (iii) Cyano complexes of Fe(II) and Fe (III).</p> <p>1.2.2 Effect of pi-bonding an ligand field splitting parameter in $\text{M} \rightarrow \text{L}$ and $\text{L} \rightarrow \text{M}$ interactions.</p> <p>1.3 Electronic States and Terms for Polyelectronic Atoms (4L)</p> <p>1.3.1 Introduction: electronic configuration and electronic states, Term symbols, coupling of spin momenta (M_s), orbital momenta (M_l) and spin-orbit coupling or Russell-Saunders coupling.</p> <p>1.3.2 Determination of Terms for p^2 electronic configuration (as in a carbon atom).</p> <p>1.3.3 Terms and micro-states for transition metal atoms/ions.</p>		
	<p style="text-align: center;">II</p>	<p>2. Properties of Coordination compounds (15L)</p> <p>2.1 Stability of Complexes (5L)</p> <p>2.1.1 Thermodynamic stability and kinetic stability of complexes with examples.</p> <p>2.1.2 Stability constants: Stepwise and overall constants and their inter-relationship.</p> <p>2.1.3 Factors affecting thermodynamic stability.</p> <p>2.1.4 Potentiometric method of determination of stability constants with example of silver-ammonia complex.</p> <p>2.2 Substitution Reactions in Octahedral Complexes (5L)</p> <p>2.2.1 Introduction, types of reactions in complexes.</p> <p>2.2.2 Ligand substitution reactions: basic mechanisms.</p> <p>2.2.3 Inert and labile complexes and</p>		<p style="text-align: center;">1</p>

		<p>electronic configurations and lability of complexes.</p> <p>2.2.4 Acid hydrolysis, base hydrolysis and anation reactions.</p> <p>2.3 Electronic Spectra (5L)</p> <p>2.3.1 Types of electronic transitions like intra –ligand transitions, charge transfer transitions and intra-metal transitions and (<i>d-d</i> or ligand field transitions for transition metals).</p> <p>2.3.2 Rules for electronic transitions: Spin and Orbital or Laporte selection rules.</p> <p>Orgel Diagrams for D Terms (i.e, d^1, d^4 and d^6.d^9 electronic configurations) and its use in interpretation of visible electronic absorption spectra of these configurations.</p>		
	III	<p>Organometallic Chemistry (15L)</p> <p>3.1 Organometallic Compounds of main group metals (6L)</p> <p>3.1.1 Introduction: General synthetic methods: (i) Oxidative addition, (ii) Metal-Metal exchange (Transmetallation), (iii) Carbanion-Halide exchange, (iv) Metal Hydrogen exchange and (v) Methylene insertion reactions.</p> <p>3.1.2 Chemical reactions: (i) Reactions with oxygen, (ii) Alkylation and arylation reactions (iii) Reactions with protic reagents and (iv) Complex formation reactions.</p> <p>3.2 Organometallic compounds of transition metals (9L)</p> <p>3.2.1 Synthesis , structure, reactions and of ferrocene.</p> <p>3.2.2 Bonding in ferrocene on the basis of VBT.</p> <p>3.2.3 Bonding in Re and Mo halide complexes.</p>		1
	IV	<p>Some Selected Topics (15L)</p> <p>4.1 Inorganic Polymers (3L)</p> <p>4.1.1 Various methods of classification with examples.</p> <p>4.1.2 Chemistry of borazine with reference to preparation , properties, structures, bonding and applications.</p> <p>4.2 Characteristics and Treatment</p>		1

		<p>of Liquid Effluent (06L)</p> <p>4.2.2 Characterization of waste: biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), aerobic and anaerobic processes.</p> <p>4.2.3 Removing of solid contaminants, physical and chemical principles such as coagulation, flocculation and sedimentation.</p> <p>4.2.4 Primary, secondary and tertiary of liquid effluents.</p> <p>4.3 Nanomaterials (04L)</p> <p>4.3.2 Introduction and importance of nanomaterials.</p> <p>4.3.3 Properties (Comparison between bulk and nanomaterials): (i) Optical properties, (ii) Electrical conductivity, and (iii) Mechanical properties.</p> <p>4.3.4 Forms of nanomaterials: nanofilms, nanolayers, nanotubes, nanowires, and nanoparticles.</p> <p>4.3.5 Chemical methods of preparation: (i) Colloidal route, and (ii) Sol-gel method.</p> <p>4.5 Inorganic Pharmaceuticals (2L)</p> <p>4.4.2 Gastrointestinal agents viz., (i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate and (ii) cathartics (magnesium sulphate and sodium phosphate).</p> <p>Topical agents viz., (i) protectives and adsorbents (talc, calamine), (ii) antimicrobial agents (potassium permanganate, tincture iodine, boric acid) and astringents (alum).</p>		
<p>USCH603</p>	<p>I</p>	<p>1.1 Spectroscopy (15L)</p> <p>1.1.1 Introduction : Electromagnetic spectrum, units of wavelength and frequency.</p> <p>1.1.2 UV- Visible Spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum, concept of Chromophore, auxochrome, bathochromic shift, Hypsochromic shift hyperchromic</p>	<p>2.5</p>	<p>1</p>

		<p>effect and chromophore-auxochrome interactions.</p> <p>1.1.3 IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.</p> <p>1.1.4 PMR Spectroscopy: Basic theory of NMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR, solvents used. Factors affecting chemical shift: (1) inductive effect (2) anisotropic effect (with reference to C=C, C\equivC, C=O and benzene ring). Spin-spin coupling and coupling constant. Proton exchange-application of deuterium exchange, Application of PMR in structure determination.</p> <p>1.1.5 Spectral characteristics of following classes of organic compounds, including benzene and monosubstituted benzenes, with respect to UV-VIS, IR, 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).</p> <p>1.1.6 Mass Spectrometry: Basic theory. Nature of mass spectrum. General rules of fragmentation. Importance of molecular ion peak, isotopic peaks, base peak, Nitrogen rule. Illustrative fragmentation of alkanes and aliphatic carbonyl compounds (No McLafferty rearrangement).</p> <p>1.1.7 Problems of structure elucidation of simple organic compounds using individual or combined use of the above spectroscopic techniques are expected. (index of hydrogen deficiency should be the first step in solving the problems).</p>		
	II	<p>2.1 Polymers (11L)</p> <p>2.1.1 Introduction: General idea of monomers, polymers, and polymerization, natural and synthetic polymers. Homopolymers and copolymers. Classification of polymers- Plastic, fibres, resins, elastomers. Thermoplastics and thermosets. Copolymers-alternating, block, random, graft.</p> <p>2.1.2 Mechanism of free radical addition</p>		1

		<p>polymerization.</p> <p>2.1.3 Elastomers: Natural and synthetic rubbers. Diene polymerization: 1,2- and 1,4- addition (cis and trans) polymerization of isoprene. 1,3-Butadiene-styrene copolymer.</p> <p>2.1.4 Stereochemistry of polymers: Tacticity. Role of Ziegler-Natta catalyst (co- ordination polymerization) in directing the tacticity in polypropylene (no mechanism).</p> <p>2.1.5 Preparation & use of polymers: (1) Addition polymers: (a) polyethylene (b) polypropylene (c) PVC (d) polystyrene (e) polyacrylonitrile (f) polyvinylalcohol (g) Teflon. (2) Condensation Polymers: (a) Polyesters (b) polyamides (c) polyurethans (d) phenol-formaldehyde resin (e) epoxy resin (f) polycarbonates.</p> <p>2.1.6 Recyclable polymers. Biodegradable polymers and their uses. Biomedical use of polymers.</p> <p>2.1.7 Additives to polymers: Plasticizers ,stabilizers and fillers.(The students are expected to identify monomers in a given polymer and draw the structure of a polymer from a given set of monomers).</p> <p>2.2 Photochemistry</p> <p>2.2.1 Introduction: Difference between thermal and photochemical reactions. Jablonski diagram, singlet and triple states, allowed and forbidden transitions, fate of excited molecules, photosensitization.</p> <p>2.2.2 Photochemical reactions of olefins: photoisomerisation, photochemical rearrangement of 1,4-dienes (di π methane)</p> <p>2.2.3 Photochemistry of carbonyl compounds: Norrish I, Norrish II cleavages, Photo reduction (e.g. benzophenone to benzpinacol).</p>		
	III	<p>3.1 Catalysts and Reagents (5L) Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).</p> <p>3.1.1 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 for</p>		1

		<p>stereo selective reduction of olefins. 3.1.2 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 CH₂, alpha to CO to CO.(5)mCPBA and R-OOH/H₂O₂ for epoxidation of C=C. (6) NBS: allylic and benzylic bromination of position alpha to CO.</p> <p>3.2 Natural Products (10L) 3.2.1 Introduction: Primary and secondary metabolites. Introduction to the following natural products with respect to the sources and classes. (Structures of the compounds specified below are expected). (a) Terpene: Isoprene and special isoprene rule.α-terpeniol, citral,camphor, α-pinene. (b) Alkaloids: nicotine,atropine. (c) Vitamins: Vitamins A and C. (d) Hormones: adrenaline, thyroxine. (e) Steroids: cholesterol, progesterone. 3.2.2 Structure determination of natural products: 3.2.2.1 Ozonolysis in terpenoids- Examples of open chain and monocyclic monoterpenes. 3.2.2.2 Hofmann exhaustive methylation and degradation in alkaloids – simple open chain and monocyclic amines.3.2.2.3 Structure determination of citral and nicotine through degradation studies. Total synthesis of degradation studies. Total synthesis of (i) Citral from 3-methylbutan-1-ol (ii) Nicotine from nicotinic acid.</p> <p>3.2.4 Commercial importance of terpenoids and alkaloids: Synthesis of camphor from α-pinene, α and β ionones, geraniol and nerol from citral.</p> <p>3.2.5</p>		
	<p>IV</p>	<p>4.1 Organometallic Chemistry (5L) 4.1.1 Intoduction: Carbon-metal bond- Nature, types reactivity. 4.1.2 Organo magnesium Compounds: Grignard reagent :Preparation, structure, and stability, Reaction with compounds containing acidic hydrogen,carbonyl compounds, cyanides and CO₂. 4.1.3 Organolithium Compounds : Preparation using alkyl/aryl halides. Reactions with compounds containing</p>		<p>1</p>

		<p>acidic hydrogen, alkyl halides, carbonyl compounds, cyanides and CO₂. Lithium dialkyl cuprates: Preparation and reactions with aliphatic /aromatic/vinyllic halides.</p> <p>4.1.4 Organozinc compounds: Preparation of dialkyl zinc. Reaction with water, acid chlorides and alkyl halides. Reformatsky reaction (with mechanism).</p> <p>4.2 Chemistry of some Important Biomolecules: (10L)</p> <p>4.2.1 α-Amino acids: Structure, configuration, Essential amino acids and their abbreviations, classification, Properties: pH dependency of ionic structure and isoelectric point. Methods of preparations: Strecker synthesis, amidomalonate synthesis, Erlenmeyer azalactone synthesis.</p> <p>4.2.2 Polypeptides and Proteins: Polypeptides: Peptide bond. Nomenclature and representation of polypeptides. Merrifield's solid phase peptide synthesis (example of di- and tri- peptides for nomenclature and synthesis). Proteins: Sources, types, functions, colloidal nature, separation based on isoelectric point, denaturation and functions. Partial and total hydrolysis. General idea of primary, secondary, tertiary and quaternary structures.</p> <p>4.2.3 Nucleic acids: Selective hydrolysis of nucleic acids. Sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA. Structure of nucleic acids (DNA and RNA): Base pairing in nucleic acids. Importance of nucleic acids-self duplication, protein synthesis.</p>		
USCH604	I	<p>Electroanalytical methods. (15L)</p> <p>1.1 D.C. Polarography (11L): Polarizable and nonpolarizable electrodes, basic principles, residual current, diffusion current, limiting current, dropping mercury electrode, supporting electrolyte half wave potential, derivation of the polarographic wave equation for a reversible reaction. Ilkovic equation, oxygen interference and its removal, maxima and maxima suppressors, polarographic cell, qualitative</p>	2.5	1

		<p>and quantitative analysis, calibration curve and standard addition method, applications. [Numerical problems expected]</p> <p>1.2 Amperometric Titrations: Basic principles, rotating platinum electrode and nature of the titration curves, applications, advantages and limitations.</p>		
	II	<p>Methods of separation-II (15L)</p> <p>2.1 Gas chromatography (6L): Gas liquid chromatography, basic principles retention time, retention volume, resolution, peak width theoretical plates. HETP, instrumentation, columns, detectors, applications.</p> <p>2.2 High Performance Liquid Chromatography (4L): Instrumentation, types of elution, U.V. and I.R. detector and applications</p> <p>2.3 Ion Exchange Chromatography (5L): Types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, capacity and its determination, factors affecting the separation of ions, applications.</p>		1
	III	<p>Treatment of analytical data-II and Titrimetric analysis-II (15L)</p> <p>3.1 Treatment of Analytical Data (6L): Distribution of random errors, Gaussian curve, students' t, confidence limits and confidence interval, criteria for rejection of result: 2.5d rule, 4.0 rule and Q test, F test, testing for significance, null hypothesis, method of averages, least squares method. Numerical problems expected]</p> <p>3.2 Complexometric Titrations (5L): General introduction, EDTA titrations, advantages and limitations of EDTA as the titrant, absolute and conditional formation constants of metal EDTA complexes, construction of titration curves, types of EDTA titrations, methods of increasing the selectivity of EDTA as a titrant, metallochromic indicators, theory and applications.</p> <p>3.3 Redox Titrations (4L): General introduction, theory of redox indicators, criterion for choosing an indicator for a redox titration, construction of the titration curves in the case of (1) Fe (II) Vs. Ce(IV)</p>		1

		(2) Fe (II) Vs. dichromate, use of diphenyl amine and ferroin as redox indicators.		
	IV	<p>Concepts in Quality and miscellaneous methods (15L)</p> <p>4.1 Total quality management (5L) : concept of quality, quality control, quality assurance total quality management, ISO series, Good laboratory practices</p> <p>4.2 Mass Spectrometry (2L): Basic principles, introduction of components only</p> <p>4.3 Thermal Methods (5L): Classification of thermal methods, thermogravimetric analysis, basic principles, instrumentation factors affecting the TG curve, applications</p> <p>4.4 Introduction to Radio Analytical Techniques (3L): Classification of the techniques, introduction to neutron activation analysis and its applications.</p>		1

Practicals

	Practicals of Course USCH601		
	<u>Physical Practicals</u>		
	Chemical Kinetics –		
	To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate.		
	Partition coefficient		
	To determine the equilibrium constant for the reaction $KI + I_2 \rightleftharpoons KI_3$ by partition method. (Partition coefficient of I_2 between CCl_4 and water is to be given)		
USCHP07	Potentiometry –	3	8
	<ol style="list-style-type: none"> To determine the strength of the given strong acid (HCl) by potentiometric titration using quinhydrone electrode (Calculation of pH from E_{cell} and the plot of (a) $\frac{\Delta E}{\Delta V}$ against V (b) pH against V graphs are expected). <p style="text-align: center;">OR</p> <ol style="list-style-type: none"> To determine pKa value of the given weak monobasic acid (CH_3COOH) by e.m.f. measurements. To determine E_{cal} at room temperature 		

	<p>and using this value, determine standard reduction potential of Ag/Ag^+ electrode at room temperature.</p> <p>Conductometry – To determine the amount of dibasic acid (Oxalic acid) by conductometric titration against strong base.</p> <p style="text-align: center;">OR</p> <p>To determine the relative strength of monochloroacetic acid and acetic acid conductometrically.</p> <p>Course USCH602 <u>Inorganic Practicals</u> Inorganic preparations</p> <ol style="list-style-type: none"> 8-(hydroxyquinoliao) magnesium (II) Tris-(acetylacetonato) iron (III) Bis-(Dimethylglyoximato) nickel (II) <p>Inorganic estimations/ Analysis</p> <ol style="list-style-type: none"> Acidity of a water sample. Fe (II) using KMnO_4 Al (back titration) complexometrically 		
USCHP08	<p style="text-align: center;">Practicals of Course USCH603</p> <p><u>Organic Practicals</u> Binary Mixture Separation Separation of mixture containing (VL + NVL) & (S + VL) components.</p> <p>Organic Preparations</p> <ol style="list-style-type: none"> Aniline/p-toluidine → N-Acetyl derivative Salicylic acid/nitrobenzene/ Acetanilide → Nitro derivative 	3	8

3. β - naphthol \rightarrow Methyl Ether derivative (Using dimethyl sulphate)
4. Acetanilide \rightarrow p-bromoacetanilide derivative
5. Aniline/ p-toluidine \rightarrow Schiff base with benzaldehyde
6. Hydroquinone/beta naphthol \rightarrow Acetyl derivative
7. Methyl salicylate/ethyl benzoate \rightarrow Acid derivative (Hydrolysis)
8. Benzaldehyde/p-nitrobenzaldehyde \rightarrow Acid (Oxidation)

Course USCH604

Analytical Practicals

1. Determination of chemical oxygen demand of a water sample.
2. Determination of percentage purity of a sample of common salt using a cation exchanger.
3. Determination of potassium content of a commercial salt sample by flame photometry.
4. Determination of acetic acid content of a vinegar sample by potentiometric titration with sodium hydroxide using quinhydrone.
5. Determination of Cr (VI) in the given solution as dichromate by the method of least squares, spectrophotometrically

T Y B Sc Chemistry

Applied Component

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD501

CREDITS: 02

LECTURES: 60

Unit			Topics	
I	1.1		General Introduction to Drugs	(8L)
		1.1.1	Definition of a drug, sources of drugs, requirements of an ideal drug, classification of drugs (based on therapeutic action),	
		1.1.2	Nomenclature of drugs: Generic name, Brand name, Systematic name	
		1.1.3	Definition of the following medicinal terms: Pharmacoon, Pharmacology, Pharmacophore, Prodrug, Half – life efficiency, LD ₅₀ , ED ₅₀ , GI ₅₀ Therapeutic Index.	
		1.1.4	Brief idea of the following terms: Receptors, Agonists, Antagonists, Drug-receptor interaction, Drug Potency, Bioavailability, Drug toxicity, Drug addiction, Spurious Drugs, Misbranded Drugs, Adulterated Drugs, Pharmacopoeia.	
	1.2		Routes of Drug Administration and Dosage Forms	(3L)
		1.2.1	Oral and Parenteral routes with advantages and disadvantages.	
		1.2.2	Formulations & combination formulation, Different dosage forms (including Patches & Adhesives, emphasis on sustained release formulations and enteric coated tablets).	
	1.3		Pharmacodynamic agents: A brief introduction of the following pharmacodynamic agents and the study with respect to their chemical structure, chemical class, therapeutic uses, and side effects.	
		1.3.1	CNS Drugs: Classification based on pharmacological actions: CNS Depressants & CNS Stimulants. Concept of sedation and hypnosis, anaesthesia. <ul style="list-style-type: none"> • Phenytoin (Hydantoin) • Trimethadione (Oxazolinediones) (Synthesis from acetone) • Alprazolam (Benzodiazepines) • Levetiracetam (Pyrrolidines) • Amphetamine (Phenethylamine) (Asymmetric synthesis from phenyl acetic acid) • Chlorpromazine (Phenothiazines) 	(4L)

UNIT-II (Drugs)

2	2.1		Analgesics, Antipyretics and Anti-inflammatory Drugs.	(4L)
		2.1.1	Analgesics and Antipyretics	

			<ul style="list-style-type: none"> • Morphine (Phenanthrene alkaloids) • Tramadol (Cyclohexanols) (Synthesis from salicylic acid) • Aspirin (Salicylates) • Paracetamol (p-Amino phenols) 	
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		2.1.2	Anti-inflammatory Drugs Mechanism of inflammation and various inflammatory conditions. <ul style="list-style-type: none"> • Steroids: Prednisolone, Betamethasone • Sodium Diclofenac, Aceclofenac (N- Aryl anthranilic acids) (Synthesis from 2,6-dichlorodiphenyl amine) 	
	2.2		Antihistaminic Drugs	(2L)
			<ul style="list-style-type: none"> •—Diphenhydramine (Ethanol amines) •—Cetirizene (Piperazine) (Synthesis from 4-Chlorobenzhydryl chloride) • Chlorpheniramine maleate (Ethyl amines) • Pantoprazole (Benzimidazoles) 	
	2.3		Cardiovascular drugs	(3L)
			Classification based on pharmacological action <ul style="list-style-type: none"> •—Isosorbide dinitrate (Nitrates) •—Valsartan (Amino acids) (structure not expected) • Atenolol (Aryloxy propanol amines) (Synthesis from 3-Hydroxy phenyl acetamide) • Amlodipine (Pyridines) • Frusemide /Furosemide (Sulfamoyl benzoic acid) • Rosuvastatin (Pyrimidine) 	
	2.4		Antidiabetic Agents	(2L)
			General idea and types of diabetes; Insulin therapy <ul style="list-style-type: none"> • Glibenclamide (Sulphonyl ureas) • Metformin (Biguanides) • Dapagliflozin (Pyranose) • Pioglitazone (Thiazolidinediones) (Synthesis from 2-(5-ethylpyridin-2-yl) ethanol) 	
	2.5		Antiparkinsonism Drugs	(2L)
			Idea of Parkinson's disease. <ul style="list-style-type: none"> • Procyclidine hydrochloride (Pyrrolidines) • Ethopropazine hydrochloride (Phenothiazines) • Levodopa (Amino acids) (Synthesis from Vanillin) 	
	2.6		Drugs for Respiratory System General idea of: Expectorants; Mucolytes; Bronchodilators; Decongestants; Antitussives	(2L)

			<ul style="list-style-type: none"> • Ambroxol (Cyclohexanol) (Synthesis from paracetamol) • Salbutamol (Phenyl ethyl amines) • Oxymetazoline (Imidazolines) • Codeine Phosphate (Opiates) 	
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Reference Books: (For units I & II)

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippincott Williams & Wilkins.
2. Text book of organic medicinal & pharmaceutical chemistry. Wilson & Gisovolds, 11th Edition by John H Block, John M Beale Jr.
3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
4. Burger's Medicinal Chemistry, Drug Discovery and Development. Abraham and Rotella. Wiley
5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitscher, Wiley.

Unit III (Dyes)

3	3.1		Introduction to the dye-stuff Industry	(5L)
		3.1.1	Dyes	
			<p>Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability.</p> <p>Definition of fastness and its properties and Mordants with examples</p> <p>Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK,</p> <p>Naming of dyes by colour index (two examples) used in dye industries.</p>	
		3.1.2	Natural and Synthetic Dyes	
			<p>Natural Dyes: Definition and limitations of natural dyes. Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll –names of the chief dyeing material/s in each natural dye [structures not expected],</p> <p>Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in the development of synthetic dyes – Emphasis on Name of the Scientist, dyes and the year of the discovery is required. (structure is not expected)</p>	
	3.2		Substrates for Dyes : Types of fibres	(3L)
		3.2.1	Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.	
		3.2.2	Semi – synthetic: definition and examples [structures not expected]	
		3.2.3	Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them	
		3.2.4	Blended fabrics: definition and examples [structures not expected]	
		3.2.5	Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces	
	3.3		Classification of dyes based on applications and dyeing methods	(7L)
		3.3.1	Dyeing methods	
			<p>Basic Operations involved in dyeing process:</p> <p>i. Preparation of fibres ii. Preparation of dyebath</p> <p>iii. Application of dyes iv. Finishing</p>	
			<p>Dyeing Method of Cotton Fibres:</p> <p>(i) Direct dyeing (ii) Vat dyeing</p> <p>(iii) Mordant dyeing (iv) Disperse dyeing</p>	

		3.3.2	Classification of dyes based on applicability on substrates (examples with structures) (a) Acid Dyes- Orange II, (b) Basic Dyes-methyl violet, (c) Direct cotton Dyes- Benzofast Yellow 5GL (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R. Coupling components. Naphthol AS, Naphthol ASG (e) Mordant Dyes-Eriochrome Black A, Alizarin. (f) Vat Dyes- Indanthrene brown RRD, (g) Sulphur Dyes- Sulphur Black T (no structure) (h) Disperse Dyes-Celliton Fast brown 3R, (i) Reactive Dyes- Cibacron Brilliant Red B,	
		3.3.3	Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.	

Unit – IV (Dyes)

4	4.1		Colour and Chemical Constitution of Dyes	(4L)
		4.1.1	Absorption of visible light, Colour of wavelength absorbed, Complementary colour.	
		4.1.2	Relation between colour and chemical constitution.	
			(i) Armstrong theory (quinonoid theory) and its limitations. (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones. (iv) Molecular Orbital Theory.	
	4.2		Unit process and Dye Intermediates	
		4.2.1	A brief idea of Unit Processes	(3L)
			Introduction to primaries and intermediates	
			Unit processes: definition and brief ideas of below unit processes: (a) Nitration (b) Sulphonation (c) Halogenation (d) Diazotization: (3 different methods & its importance) (e) Ammonolysis (f) Oxidation NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)	

		4.2.2	Preparation of the Following Intermediates	(8L)
			<u>Benzene derivatives</u> : Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes; o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG	
			<u>Naphthalene Derivative</u> : Schaeffer acid; Tobias acid; Naphthionic acid; N.W. acid; cleve-6-acid; H-acid; Naphthol AS	
			<u>Anthracene Derivative</u> : 1-Nitroanthraquinone; 1-Aminoanthraquinone Anthraquinone-2-sulphonic acid; Benzanthrone.	

References (For Units III & IV):

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973

I] Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD5P1

CREDITS: 02

1. Estimation of Ibuprofen (back titration method)
2. Estimation of Acid neutralizing capacity of a drug
3. Preparation of Aspirin from salicylic acid.
4. Separation of components of natural pigments by paper chromatography (eg: chlorophyll)

II] Project:

Preparation of Orange II dye (semi-microscale 1.0gms) and its use for dyeing different fabrics

SEMESTER VI**(Drugs and Dyes)****COURSE CODE: USACDD601****CREDITS: 02****LECTURES: 60****UNIT – I (Drugs)**

1	1.1		Drug Discovery, Design and Development	(6L)
		1.1.1	Discovery of a Lead compound: Screening, drug metabolism studies and clinical observation, Lipinski's rule of 5	
		1.1.2	Medicinal properties of compounds from Natural Sources: Anti-infective and anticancer properties of Turmeric (Curcumin)	
		1.1.3	Development of drug: The Pharmacophore identification, modification of structure or functional group, Structure activity relationship (Sulphonamides).	
		1.1.4	Structure modification to increase potency: Homologation, Chain branching and Extension of the structure.	
		1.1.5	Computer assisted drug design.	
	1.2		Drug Metabolism: Introduction, Absorption, Distribution, Bio-transformation, Excretion Different types of chemical transformation of drugs with specific examples.	(3L)
	1.3		Chemotherapeutic Agents: Study of the following chemotherapeutic agents with respect to their chemical structure, chemical class, therapeutic uses, side effects and introduction to MDR wherever applicable.	
		1.3.1	Antibiotics and antivirals: Definition, <ul style="list-style-type: none"> • Amoxicillin (β-lactam antibiotics) • Cefpodoxime (Cephalosporins) • Doxycycline (Tetracyclines) • Levofloxacin (Quinolones) (Synthesis from 2,3,4 – Trifluoro -1-nitrobenzene) • Aciclovir/Acyclovir (Purines) 	(2L)
		5.3.2	Antimalarials: Types of malaria; Symptoms; Pathological detection during window period (Life cycle of the parasites not to be discussed) <ul style="list-style-type: none"> • Chloroquine (3-Amino quinolones) • Artemether (Benzodioxepins) Following combination to be discussed: Artemether-Lumefantrine (no structure)	(2L)

	1.3. 3	Anthelmintics and AntiFungal agents Drugs effective in the treatment of Nematodes and Cestodes infestations. <ul style="list-style-type: none"> • Diethyl carbamazine (Piperazines) • Albendazole (Benzimidazoles) (Synthesis from 2-Nitroaniline) • Clotrimazole (Imidazole) • Fluconazole (Triazole) (Synthesis from 1- Bromo – 2,4-difluorobenzene) 	(2L)
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UNIT – II(Drugs)
Chemotherapeutic Agents continued.

2	2.1	Antiamoebic Drugs Types of Amoebiasis <ul style="list-style-type: none"> • Metronidazole, Ornidazole, Tinidazole (Imidazole) Synthesis of Metronidazole from glyoxal by Debus-Radziszewski imidazole synthesis route Following combination therapy to be discussed: Ciprofloxacin-Tinidazole	(1L)
	2.2	Antitubercular and Antileprotic Drugs Types of Tuberculosis; Symptoms and diagnosis of Tuberculosis. Types of Leprosy. General idea of Antibiotics used in their treatment. <ul style="list-style-type: none"> • PAS (Amino salicylates) • Isoniazide (Hydrazides) • Pyrazinamide (Pyrazines) • (+) Ethambutol (Aliphatic diamines) (Synthesis from 1- Nitropropane) • Dapsone(Sulphonamides) (Synthesis from 4- Chloronitrobenzene) • Clofazimine (Phenazines) • Bedaquiline (Quinoline) Following combination therapy to be discussed: (i) Rifampin + Ethambutol + Pyrazinamide (ii) Rifampin + Isoniazide + Pyrazinamide	(3L)
	2.3	Anti-Neoplastic Drugs Idea of malignancy; Causes of cancer Brief idea of Immuno Stimulants &Immuno depressants <ul style="list-style-type: none"> • Lomoustine (Nitrosoureas) • Anastrozole(Triazoles) (Synthesis from 3,5-bis (bromo methyl) toluene) • Cisplatin (Chloro Platinum) • Vincristine, Vinblastine, Vindesine) (Vinca alkaloids) (structure not expected) 	(2L)
	2.4	Anti-HIV Drugs Idea of HIV pathogenicity, Symptoms of AIDS <ul style="list-style-type: none"> • AZT/Zidovudine, Lamivudine,DDI (Purines) 	(1L)
	2.5	Drug Intermediates: Synthesis and uses 1. 2,3,6-Triamino-6- hydroxypyrimidine from Guanidine	(2L)

		2. p-[2'-(5-Chloro-2-methoxy benzamido) ethyl]-benzenesulphonamide from Methyl-5-chloro-2-methoxybenzene 3. 3-(p-Chlorophenyl)-3-hydroxypiperidine from 3-Chloroacetophenone 4. p-Acetyl amino benzenesulphonyl chloride from Aniline 5. Epichlorohydrine from propene	
	2.6	Nano particles in Medicinal Chemistry Introduction; Carbon nano particles (structures) and Carbon nano tubes: <ul style="list-style-type: none"> • Functionalization for Pharmaceutical applications • Targeted drug delivery • In vaccine (Foot and mouth disease) • Use in Bio-physical treatment. Gold nano particles in treatment of: Cancer; Parkinsonism; Alzheimer. Silver nano particles: Antimicrobial activity.	(4L)
	2.7	Drugs and Environmental Aspects <ul style="list-style-type: none"> • Impact of Pharma-industry on environment, • International regulation for human experimentation with reference to: "The Nuremberg Code" and "The Helsinki Declaration". 	(2L)

Reference Books (For Units I & II):

1. Foye's principles of medicinal chemistry. 6th Edition, Edited by Davis William & Thomas Lemke, Indian edition by B I Publication Pvt Ltd, Lippincott Williams & Wilkins.
 2. Text book of organic medicinal & pharmaceutical chemistry. Wilson & Gisovolds, 11th Edition by John H Block, John M Beale Jr.
 3. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
 4. Burger's Medicinal Chemistry, Drug Discovery & Development. Abraham & Rotella. Wiley
 5. Medicinal chemistry. Ashutosh Kar, New Age International Pvt. Ltd Publisher. 4th edition.
 6. Medicinal chemistry. V.K. Ahluwalia and Madhu Chopra, CRC Press.
 7. Principle of medicinal chemistry. Vol 1 & 2 S. S. Kadam, K. R. Mahadik, K. G. Bothara
 8. The Art of Drug synthesis. Johnson and Li. Wiley, 2007.
 9. The organic chemistry of drug design & drug action. 2nd ed. By Richard B Silvermann, Academic Press.
 10. The Organic Chemistry of Drug Synthesis. Lednicer and Mitscher, Wiley.
 11. Text book of drug design and discovery. Povl-Krog-Sgaard-Larsen, Tommy Liljefors and ULF Madsen, 3rd Edition Taylor & Francis.
 12. Bio-applications of nanoparticles. Edited by Warren C.W. Chan, Springer Publication.
 13. Nanoparticle and technology for drug delivery (Drugs and pharmaceutical sciences). Ram B.Gupta & Uday B.Kompella Pub. Informa Healthcare.
 14. Nano forms of carbon and its applications. Edited by Maheshwar Sharon and Madhuri Sharon. Monad Nanotech Pvt. Ltd.
 15. Environmental Chemistry. A. K. De
 16. Text Book on Law and Medicine. Chokhani and Ghormade. 2nd Edition. Hind Law House, Pune.
 17. Essentials of Medical Pharmacology. K D Tripathi, Jaypee Brothers Medical publishers Pvt. Ltd.
- Practical organic chemistry, Vogel.

SEMESTER VI

Unit – III (Dyes)

3	3.1		Classification of Dyes based on Chemical Constitution and Synthesis of Selected Dyes (Synthesis of the dyes marked with * is expected)	(12L)
			i) Nitro Dye: Naphthol Yellow S	
			ii) Nitroso Dye: Gambine Y	
			iii) Azo dyes: a) Monoazo dyes: Orange IV *(from sulphanilic acid) & Eriochrome Black T* (from β -naphthol) b) Bisazo dyes: Congo Red* (from nitrobenzene) c) Trisazo Dye: Direct Deep Black EW* (from benzidine)	
			iv) Diphenylmethane dye: Auramine O* (from N,N-dimethyl aniline)	
			v) Triphenylmethane dye: a) Diamine series: Malachite Green* (from benzaldehyde) b) Triamine series: Acid Magenta c) Phenol series: Rosolic acid	
			vi) Heterocyclic Dyes: a) Thiazine dyes: Methylene Blue b) Azine dyes: Safranin T* (from o-toluidine) c) Xanthene Dyes: Eosin* (from phthalic anhydride) d) Oxazine Dyes: Capri Blue e) Acridine Dyes: Acriflavine	
			vii) Quinone Dyes: a) Naphthaquinone: Naphthazarin b) Anthraquinone Dyes: Indanthrene Blue* (from anthraquinone)	
			viii) Indigoid Dyes: Indigo* (from aniline + monochloroacetic acid)	
			ix) Phthalocyanine Dyes: Monastral Fast Blue B	
	3.2		Health and Environmental Hazards of Synthetic Dyes and their Remediation Processes	(3L)
		3.2.1	Impact of the textile and leather dye Industry on the environment with special emphasis on water pollution	
		3.2.2	Health Hazards: Toxicity of dyes w.r.t food colours.	
		3.2.3	Effluent Treatment Strategies: Brief introduction to effluent treatment plants (ETP) Primary Remediation processes: (Physical Processes) Sedimentation, Aeration, Sorption (activated charcoal, fly ash etc.) Secondary Remediation processes: Biological Remediation – Biosorption, bioremediation and biodegradation Chemical Remediation: Oxidation Processes (chlorination), Coagulation-flocculation-Precipitation	

Unit – IV (Dyes)

4	4.1		Non-textile uses of dyes:	(8L)
		4.1. 1	Biomedical uses of dyes i) Dyes used in formulations (Tablets, capsules, syrups etc) Indigo carmine, Sunset yellow, Tartrazine ii) Biological staining agents Methylene blue, Crystal violet and Safranin T iii) DNA markers Bromophenol blue, Orange G, Cresol red iv) Dyes as therapeutics Mercurochrome, Acriflavine, Crystal Violet, Prontosil	
		4.1. 2	Dyes used in food and cosmetics: i) Properties of dyes used in food and cosmetics ii) Introduction to FDA and FSSAI iii) Commonly used food colours and their limits	
		4.1. 3	Paper and leather dyes i) Structural features of paper and leather ii) Dyes applicable to paper and leather	
		4.1. 4	Miscellaneous dyes i) Hair dyes ii) Laser dyes iii) Indicators iv) Security inks iv) Coloured smokes and camouflage colours	
	4.2		Pigments	(3L)
			Definition of pigments, examples, properties of pigments, difference between dyes and pigments. Definition of Lakes and Toners	
	4.3		Dyestuff Industry - Indian Perspective	(4L)
		4.3. 1	Growth and development of the Indian Dyestuff Industry	
		4.3. 2	Strengths, Weaknesses, Opportunities and Challenges of the Dyestuff industry in India	
		4.3. 3	Make in India - Future Prospects of the Dye Industry	

References (For Units III & IV)

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995
3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry, Sodhi. G. S., Alpha Science International, 2009
6. Planning Commission, Niti Aayog, FSSAI and FDA websites
7. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
8. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982

Practicals

SEMESTER V

(Drugs and Dyes)

COURSE CODE: USACDD6P1

CREDITS: 02

1. O-Methylation of β -naphthol.
2. Preparation of Paracetamol from p-aminophenol.
3. Preparation of Fluorescein
4. TLC of a mixture of dyes (safranin-T, Indigo carmine, methylene blue)

II] Preparation of monograph of any one drug from syllabus by I.P. method.

OR

Industrial visit Report.
