

**Telangana State Council of Higher Education, Govt. of Telangana B.Sc., CBCS Common  
Core Syllabi for all Universities in Telangana  
PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN  
B.Sc., Chemistry**

<b>FIRST YEAR- SEMSTER I</b>				
<b>CODE</b>	<b>COURSE TITLE</b>	<b>COURSE TYPE</b>	<b>HPW</b>	<b>CREDITS</b>
BS 101	Communication	AECC-1	2	2
BS 102	English	CC-1A	5	5
BS 103	Second language	CC-2A	5	5
BS 104	Optional I	DSC-1A	4T+2P=6	4+1=5
BS 105	Optional II	DSC-2A	4T+2P=6	4+1=5
<b>BS 106</b>	<b>Optional III- Chemistry - I</b>	<b>DSC-3A</b>	<b>4T</b> } = 6	<b>4</b> } = 5
	<b>Laboratory Course – I (Qualitative Analysis – I)</b>		<b>2P</b> }	<b>1</b> }
<b>Total Credits</b>				<b>27</b>
<b>FIRST YEAR- SEMSTER II</b>				
BS 201	Environmental studies	AECC-2	2	2
BS 202	English	CC-1B	5	5
BS 203	Second language	CC-2B	5	5
BS 204	Optional I	DSC-1B	4T+2P=6	4+1=5
BS 205	Optional II	DSC-2B	4T+2P=6	4+1=5
<b>BS 206</b>	<b>Optional III- Chemistry - II</b>	<b>DSC-3B</b>	<b>4T</b> } = 6	<b>4</b> } = 5
	<b>Laboratory Course - II (Qualitative Analysis – II)</b>		<b>2P</b> }	<b>1</b> }
<b>Total Credits</b>				<b>27</b>
<b>SECOND YEAR- SEMSTER III</b>				
BS 301	<b>Safety Rules in Chemistry Laboratory and Lab Reagents</b>	<b>SEC-I</b>	2	2
BS 302	English	CC-1C	5	5
BS 303	Second language	CC-2C	5	5
BS 304	Optional I	DSC-1C	4T+2P=6	4+1=5
BS 305	Optional II	DSC-2C	4T+2P=6	4+1=5
<b>BS 306</b>	<b>Optional III- Chemistry - III</b>	<b>DSC-3C</b>	<b>4T</b> } = 6	<b>4</b> } = 5
	<b>Laboratory Course - III (Quantitative Analysis – I)</b>		<b>2P</b> }	<b>1</b> }
<b>Total Credits</b>				<b>27</b>
<b>SECOND YEAR- SEMSTER IV</b>				
BS 401	<b>Remedial Methods for Pollution, Drinking Water and Soil Fertility</b>	<b>SEC-2</b>	2	2
BS 402	English	CC-1D	5	5
BS 403	Second language	CC-2D	5	5
BS 404	Optional I	DSC-1D	4T+2P=6	4+1=5
BS 405	Optional II	DSC-2D	4T+2P=6	4+1=5
<b>BS 406</b>	<b>Optional III- Chemistry - IV</b>	<b>DSC-3D</b>	<b>4T</b> } = 6	<b>4</b> } = 5
	<b>Laboratory Course - IV (Quantitative Analysis – II)</b>		<b>2P</b> }	<b>1</b> }
<b>Total Credits</b>				<b>27</b>

\* **Optional III Chemistry** AECC: Ability Enhancement Compulsory Course; SEC: Skill Enhancement Course;  
DSC: Discipline Specific Course; GE: Generic Elective;

**B.Sc. Chemistry II Year**  
**Semester III**  
**Skill Enhancement Course- I (SEC-I)**

**301 SEC: Safety Rules in Chemistry Laboratory and Lab Reagents**

**Unit I: Laboratory Safety Rules and Regulations.**

General rules and regulations for lab safety: Minimizing Risks of Hazards, Personal Protective Equipment (PPE) - Hair, Dressing for the Laboratory, Eye Protection, Eye-wash fountain, Gloves, Laboratory Protocols, Labeling Chemicals, Careful reading of labels Prevention of Inhaling Harmful Chemicals, Guide to Chemical Hazards, Chemical Spills etc., Accidents use of fire extinguisher and first aid kit in the laboratory, safety symbols- Preparation of the charts by the students and display of charts in chemistry labs. Calibration of fractional weights, calibration of glass ware - burette, pipette, standard flask, Normality/Molarity and specific gravity of concentrated acids – Preparation of dilute solutions (Numerical problems). Precautions to be taken in the preparation of dilute acids and bases and bases. Preparation of stock solutions of salts with specific examples. Properties of primary standard salt and preparation of standard solution. Good laboratory practices-maintenance of observation book record.

**UNIT 2: Preparation of Lab Reagents:** Preparation of indicators and use of indicators in volumetric analysis- acid base titrations, redox titrations, precipitation titrations and complexometric titrations. Role of an indicator in detecting end point (Phenolphthalein, Methyl orange, Methyl-red, Potassium Chromate, Diphenylamine, EBT, Murexide, etc). Preparation of buffers – pH 10 ammonical buffer and acetate buffer solutions. Preparation of commonly used reagents : Ammonium hydroxide solution, Ammonium molybdate reagent, Ammonium hydrogen phosphate solution, Bayer's reagent, Benedict's solution, Bromine water, Dimethyl glyoxime reagent, 2,4-Dinitrophenyl hydrazine reagent, Eriochrome black-T reagent Fehling solution, Ferric chloride solution, Ferrous sulphate solution, Iodine solution, Molisch's reagent, Nessler's reagent, Neutral FeCl<sub>3</sub>, Schiff's reagent, Silver nitrate solution, Sodium carbonate solution , Sodium hydroxide (Caustic soda) solution, Starch solution, Tollen's reagent.

(reference work and submission of assignments). Charts preparation depicting course content.

**RECOMMENDED BOOKS**

1. Vogel's Text Book of Quantitative Chemical Analysis, 5<sup>th</sup> edition.
2. Vogel's Text Book of macro and semimicro qualitative inorganic analysis. G. Svehla, 5<sup>th</sup> edition.
3. Chemistry Reagent Manual Prepared by Chemistry Department, SGTB Khalsa College under DBT's Star College Scheme, University of Delhi ( Available: online)
4. American Chemical Society Safety in Academic Chemistry Laboratories 8<sup>th</sup> edition.

[Course objectives (CO)]

- To improve the skills of students in the application of theory and practical knowledge.
- To fill the gap between theory and practicals.
- To train the students in understanding laboratory safety rules and to improve the skills in preparation of laboratory reagents]

**B.Sc II yr CHEMISTRY**  
**SEMESTER WISE SYLLABUS**  
**SEMESTER III**  
**Paper-III**  
**Chemistry - III**

**Unit-I (Inorganic Chemistry)**

**15 h (1 hr/week)**

**S3-I-1: Chemistry of f-block elements:**

**6 h**

Chemistry of Lanthanides: Position in periodic table, Electronic structure, oxidation state, ionic and atomic radii- lanthanide contraction- cause and consequences, anomalous behavior of post lanthanides-complexation- type of donor ligands preferred. Magnetic properties- paramagnetism. Colour and spectra, f-f transitions –occurrence and separation – ion exchange method, solvent extraction.

Chemistry of actinides- general features – electronic configuration, oxidation state, actinide contraction, colour and complex formation. Comparison with lanthanides.

**S3-I-2: Symmetry of molecules**

**5 h**

Symmetry operations and symmetry elements in molecules. Definition of Axis of symmetry types of  $C_n$ , Plane of symmetry ( $\sigma_h$ ,  $\sigma_v$ ,  $\sigma_d$ ) Center of symmetry and improper rotational axis of symmetry ( $S_n$ ). Explanation with examples.

**S3-I-3: Non – aqueous solvents**

**4 h**

Classification and characteristics of a solvent. Reactions in liquid ammonia – physical properties, auto-ionisation, examples of ammonium acids and ammonium bases. Reactions in liquid ammonia – precipitation, neutralization, solvolysis, solvation - solutions of metals in ammonia, complex formation, redox reactions. Reactions in HF – autoionisation, reactions in HF – precipitation, acid – base reactions, protonation.

**Unit - II (Organic chemistry)**

**15 h (1 hr/week)**

**S3-O-1: Alcohols**

**6 h**

Preparation:  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols using Grignard reagent, Ester hydrolysis, Reduction of Carbonyl compounds, carboxylic acids and esters. Physical properties: H-bonding, Boiling point and Solubility. Reactions with Sodium, HX/ $ZnCl_2$  (Lucas reagent), esterification, oxidation with PCC, alk.  $KMnO_4$ , acidic dichromates, conc.  $HNO_3$  and Oppenauer oxidation.

Diols: Pinacol - pinacolone rearrangement

**Phenols:** Preparation: (i) from diazonium salts of anilines, (ii) from benzene sulphonic acids and (iii) Cumene hydroperoxide method.

Properties: Acidic nature, formation of phenoxide and reaction with R-X, electrophilic substitution nitration, halogenation and sulphonation. Reimer Tiemann reaction, Gattermann-Koch reaction, Azo-coupling reaction, Schotten-Boumann reaction, Houben-Hoesch condensation,  $FeCl_3$  reaction.

**S3-O-2: Ethers and epoxides****2 h**

Nomenclature, preparation by (a) Williamson's synthesis (b) from alkenes by the action of conc.  $\text{H}_2\text{SO}_4$ . Physical properties – Absence of Hydrogen bonding, insoluble in water, low boiling point. Chemical properties – inert nature, action of conc.  $\text{H}_2\text{SO}_4$  and HI.

**S3-O-3 Carbonyl compounds****7 h**

Nomenclature of aliphatic and aromatic carbonyl compounds and isomerism.

Preparation of aldehydes & ketones from acid chloride, 1,3-dithianes, nitriles and from carboxylic acids. Special methods of preparing aromatic aldehydes and ketones by (a) Oxidation of arenes (b) Hydrolysis of benzal halides Physical properties – absence of Hydrogen bonding. Keto-enol tautomerism, polarisability of carbonyl groups, reactivity of the carbonyl groups in aldehydes and ketones. Chemical reactivity: Addition of [a]  $\text{NaHSO}_3$  (b)  $\text{HCN}$  (c)  $\text{RMgX}$  (d)  $\text{NH}_3$  (e)  $\text{RNH}_2$  (f)  $\text{NH}_2\text{OH}$  (g)  $\text{PhNHNH}_2$  (h) 2,4DNP (Schiff bases). Addition of  $\text{H}_2\text{O}$  to form hydrate (unstable), comparison with chloral hydrate (stable), addition of alcohols - hemiacetal and acetal formation. Base catalysed reactions with mechanism- Aldol, Cannizzaro reaction, Perkin reaction, Benzoin condensation, haloform reaction, Knoevenagel condensation. Oxidation reactions –  $\text{KMnO}_4$  oxidation and auto oxidation, reduction – catalytic hydrogenation, Clemmenson's reduction, Wolf- kishner reduction, Meerwein Ponnoff Verly reduction, reduction with LAH,  $\text{NaBH}_4$ . Analysis – 2,4 -DNP test, Tollen's test, Fehlings test, Schiff's test, haloform test (with equations).

**UNIT – III (Physical Chemistry)****15 hr (1h/week)****S3-P-1: Phase Rule****6 h**

Statement and meaning of the terms – Phase, Component and degrees of freedom, Gibb's Phase rule, phase equilibria of one component system – water system. Phase equilibria of two-component system – Solid-Liquid equilibria, simple eutectic – Pb-Ag system, desilverisation of lead. Solid solutions – compound with congruent melting point – Mg-Zn system and incongruent melting point –  $\text{NaCl-H}_2\text{O}$  system.

**S3-P-2: Colloids & surface chemistry****9 h**

Definition of colloids. Classification of colloids. Solids in liquids (sols): preparations and properties – (including Kinetic, Optical and Electrical stability of colloids) Protective action. Hardy-Schultz law, Gold number. Liquids in liquids (emulsions): Types of emulsions, preparation and emulsifier. Liquids in solids (gels); Classification, preparations and properties, General applications of colloids.

Micelles: Classification of surface active agents. Surfactant action, micellization and micellar interactions, Structure of micelles – spherical and lamellar. Critical micellar concentration (CMC). Factors affecting the CMC of surfactants. Counter ion binding to micelles.

**Adsorption:** Types of adsorption, Factors influencing adsorption. Freundlich adsorption isotherm. Langmuir theory of unilayer adsorption isotherm. Applications.

## Unit –IV (General Chemistry)

15 h (1h/week)

### S3-G-1: *Nanomaterials*:

3h

Nano structured materials – Definition, size, description of graphene, fullerenes, carbon nano tubes. Synthetic techniques, bottom-up-sol-gel method, top-down, electro deposition method. Production of carbon nano tubes – arc discharge, laser vaporization methods. General applications of nano materials.

### S3-G-2: Stereochemistry of carbon compounds

10 h

Isomerism: Definition of isomers. Classification of isomers: Constitutional and Stereoisomers - definition and examples. Constitutional isomers: chain, functional and positional isomers. Stereoisomers: enantiomers and diastereomers – definitions and examples.

Optical activity: Definition, wave nature of light, plane polarised light, optical rotation and specific rotation, chiral centers. Chiral molecules: definition and criteria - absence of plane, center and  $S_n$  axis of symmetry – asymmetric and dissymmetric molecules. Examples of asymmetric molecules (Glyceraldehyde, Lactic acid, Alanine) and dissymmetric molecules (trans-1,2-dichlorocyclopropane). Molecules with constitutionally symmetrical chiral carbons (Tartaric acid) Molecules with constitutionally unsymmetrical chiral carbons (2,3-dibromopentane) Number of enantiomers and mesomers - calculation. D, L & R, S configuration for asymmetric and dissymmetric molecules (Allenenes, spiro compounds and biphenyls), Cahn-Ingold-Prelog rules. Racemic mixture, Racemisation and Resolution techniques. Geometrical isomerism with reference to alkenes and cyclo alkanes– cis, trans and E, Z configuration.

### S3-G-3: Conformational analysis

2 h

Classification of stereoisomers based on energy. Definition and examples Conformational and configurational isomers. Conformational analysis of ethane, n-butane, 1,2-dichloroethane, 2-chloroethanol and methylcyclohexane

## Referances:

### Unit- I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications (1996).
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn Van Nostrand Reinhold Company(1977)
- 3.
4. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson and Paul.L. Gaus 3<sup>rd</sup> edn Wiley Publishers (2001).
5. Inorganic Chemistry Principles of structure and reactivity by James E.Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> edn. (2006)
6. Chemistry of the elements by N.N.Greenwood and A. Earnshaw Pergamon Press (1989).
7. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press (1999).
8. Textbook of Inorganic Chemistry by R Gopalan(Universities Press(2012)
9. College Practical chemistry by V K Ahluwalia, Sunitha Dhingra and Adarsh Gulati Universities Press (India) Limited(2012)

### Unit- II

1. Text book of organic chemistry by Soni. Sultan Chand & Sons; Twenty Ninth edition (2012)
2. General Organic chemistry by Sachin Kumar Ghosh. New Age Publishers Pvt Ltd (2008)
3. Text book of organic chemistry by Morrison and Boyd. Person(2009)
4. Text book of organic chemistry by Graham Solomons. Wiley(2015)
5. Text book of organic chemistry by Bruice Yuranis Powla. (2012)
6. Text book of organic chemistry by C N pillai CRC Press (2012)

### Unit III

1. Principles of physical chemistry by Prutton and Marron. The Macmillan Company; 4th edition (1970)
2. Text Book of Physical Chemistry by Soni and Dharmahara. Sulthan Chand & sons.(2011)
3. Text Book of Physical Chemistry by Puri and Sharma. S. Nagin chand and Co. (2017)
4. Text Book of Physical Chemistry by K. L. Kapoor. (2012)
5. Colloidal and surface chemistry , M. Satake, Y. Hayashi, Y.Mido, S.A.Iqbal and M.S.sethi, Discovery Publishing Pvt.Ltd (2014)
6. Material science by Kakani & Kakani, New Age International(2016)

### Unit IV

1. Text book of organic chemistry by Morrison and Boyd, Person(2009)
2. Text book of organic chemistry by Graham solomons, Wiley(2015)
3. Text book of organic chemistry by Sony, Sultan Chand & Sons; Twenty Ninth edition (2012)
4. Text book of organic chemistry by Bruice yuranis Powla, (2012)
5. General Organic chemistry by Sachin kumar Ghosh, New Age Publishers Pvt Ltd (2008)

## Laboratory Course

### Paper III- Quantitative Analysis - I

45hrs (3 h / week)

#### Acid - Base titrations

1. Estimation of Carbonate in Washing Soda.
2. Estimation of Bicarbonate in Baking Soda.
3. Estimation of Carbonate and Bicarbonate in the Mixture.
4. Estimation of Alkali content in Antacid using HCl.

#### Redox Titrations

1. Determination of Fe(II) using  $K_2Cr_2O_7$
2. Determination of Fe(II) using  $KMnO_4$  with sodium oxalate as primary standard.
3. Determination of Cu(II) using  $Na_2S_2O_3$  with  $K_2Cr_2O_7$  as primary standard

**B.Sc. Chemistry II Year**  
**Semester IV**  
**Skill Enhancement Course- II (SEC -II)**  
**401 SEC - REMEDIAL METHODS FOR POLLUTION, DRINKING WATER AND**  
**SOIL FERTILITY STANDARDS**

**UNIT I: Remedial Methods for Pollution**

Prevention and control of air pollution, Ozone hole-causes and harm due to ozone depletion. The effect of CFC's in Ozone depletion and their replacements. Global Warming and Greenhouse Effect-Precautions to control global warming. Deleterious effect of pollutants - Endangered Monuments- acid rain. Precautions to protect monuments. Sources of Radiation pollution - Chernobyl accident and its Consequences. Radiation effect by the usage of cell phones and protection tips. Deleterious effects of cell phone towers and health hazards. Sources of water pollution-(i). Pollution due to pesticides and inorganic chemicals, (ii). Thermal pollution (iii). Ground water pollution (iv). Eutrophication. Methods for control of water pollution and water recycling. Dumping of plastics in rivers & oceans and their effect on aquatic life.

Determination of (i) Dissolved Oxygen and (ii) Chemical Oxygen Demand in polluted water - Illustration through charts (or) demonstration of experiments. Sources of soil pollution (i). Plastic bags, (ii). Industrial and (iii). Agricultural sources. Control of soil pollution. Environmental laws in India. Environmental benefits of planting trees.

**UNIT II: Drinking Water and Soil Fertility Standards and Analysis**

Water Quality and Common Treatments for Private Drinking Water Systems: Drinking Water Standards-Primary Drinking Water Standards : Inorganics, Organics and Volatile Organic Chemicals. Secondary Drinking Water Standards-Inorganics and Physical Problems. Water Testing, Mineral Analysis, Microbiological Tests, Pesticide and Other Organic Chemical Tests. Principle involved in Water Treatment Techniques. (i) Reverse osmosis (ii) Disinfection methods such as chlorination, ultraviolet light, ozonation etc (iii) Chemical oxidation and (iv) Ion exchange (water softeners). Visit to nearby drinking water plants and interaction at sites.

Introduction to Soil Chemistry- Basic Concepts. Effect of pH on nutrient availability. Macronutrients and their effect on plants -Carbon, Hydrogen, Oxygen, Nitrogen and Phosphorus other macronutrients-Calcium, Magnesium and Sulfur. Micronutrients and their effect on plants. Boron ( $B_4O_7^{2-}$ ), Copper ( $Cu^{2+}$ ), Iron ( $Fe^{2+}$ ,  $Fe^{3+}$ ) Manganese ( $Mn^{2+}$ ) Molybdenum ( $MoO_4^{2-}$ ) Zinc ( $Zn^{2+}$ ) Cobalt ( $Co^{2+}$ ) Chlorine ( $Cl^-$ ) and Others. Determination of soil nitrogen by Kjeldahl method- Illustration through charts (Or) demonstration of experiment.

Visit to nearby agricultural farms and interaction with farmers. Discussion with farmers on the use of Soil Analysis Kits.

**References:**

1. A Text book for 'Remedial methods for pollution, drinking water and soil fertility standards', First Edition, Authors: Dr Mudvath Ravi, Gopu Srinivas, Putta Venkat Reddy, Vuradi Ravi Kumar, Battini Ushaiah, ISBN No. 978-93-5311-183-0.
2. Remedial methods for pollution, drinking water and soil fertility standards, Author: Dr G. Vanjatha.
3. Remedial methods for pollution, drinking water and soil fertility standards, Telugu version, Authors: Dr N. Yogi Babu, Dr. G. Vanajatha, M. Srilatha.
4. Environmental Pollution, [download.nos.org/333courseE/10.pdf](http://download.nos.org/333courseE/10.pdf)



5. CFC Replacements, butane.[chem.uiuc.edu/pshapley/Environmental/L21/3.html](http://chem.uiuc.edu/pshapley/Environmental/L21/3.html)
6. Effects of Acid Rain on Buildings  
[www.air-quality.org.uk/12.php](http://www.air-quality.org.uk/12.php)
7. Acid Rain Effects - Buildings - Chemistry  
[chemistry.elmhurst.edu/vchembook/196buildings.html](http://chemistry.elmhurst.edu/vchembook/196buildings.html)
8. How to protect national heritage - ways to protect monuments  
[www.youthkiawaaz.com/2011/03/how-to-protect-national-heritage/](http://www.youthkiawaaz.com/2011/03/how-to-protect-national-heritage/).
9. Chernobyl nuclear power plant accident - NRC  
[www.nrc.gov/reading-rm/doc-collections/fact-sheets/chernobyl-bg.pdf](http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/chernobyl-bg.pdf)
10. Side-effects of harmful radiation from mobile phones and towers  
[pib.nic.in/newsite/printrelease.aspx?relid=116304](http://pib.nic.in/newsite/printrelease.aspx?relid=116304)
11. Cell Phone Radiation Protection - 12 Highly Effective Tips <https://www.electricsense.com/775/how-to-protect-yourself-from-cell-phone-radiation/>
12. Chemical Waste That Impact on Aquatic Life or Water Quality  
[blog.idrenvironmental.com/chemical-waste-that-impact-on-aquatic-life-or-water-quality](http://blog.idrenvironmental.com/chemical-waste-that-impact-on-aquatic-life-or-water-quality)
13. Trees and Your Environment - Clean Air Gardening  
[www.cleanairgardening.com/plantingtrees](http://www.cleanairgardening.com/plantingtrees)
14. water quality and common treatments for private drinking water .  
[extension.uga.edu/publications/detail.html?number=b939](http://extension.uga.edu/publications/detail.html?number=b939)
15. Soil chemistry  
<https://casfs.ucsc.edu/about/publications/Teaching-Organic-Farming/PDF-downloads/2.2-soil-chemistry.pdf>
16. Soil Analysis-Determination of Available Nitrogen ... - Amrita Virtual Lab  
[vlab.amrita.edu/?sub=2&brch=294&sim=1551&cnt=1](http://vlab.amrita.edu/?sub=2&brch=294&sim=1551&cnt=1)
17. Determination of dissolved oxygen (DO)  
[www.cutm.ac.in/pdf/env%20engg%20lab%20manual.pdf](http://www.cutm.ac.in/pdf/env%20engg%20lab%20manual.pdf)
18. Determination of chemical oxygen demand of wastewater  
[www.pharmaguideline.com](http://www.pharmaguideline.com) > *quality control* > *test*

**B.Sc II yr CHEMISTRY**  
**SEMESTER WISE SYLLABUS**  
**SEMESTER IV**  
**Paper-IV**  
**Chemistry - IV**

**Unit-I (Inorganic Chemistry)**

**15h (1 h/week)**

**S4-I-1: Coordination Compounds-I**

**7 h**

Simple inorganic molecules and coordination complexes. Nomenclature – IUPAC rules, 1. Brief review of Werner's theory, Sidgwick's electronic interpretation and EAN rule and their limitations. (Valence bond theory (VBT) – postulates and application to (a) tetrahedral complexes  $[\text{Ni}(\text{NH}_3)_4]^{2+}$ ,  $[\text{NiCl}_4]^{2-}$  and  $[\text{Ni}(\text{CO})_4]$  (b) square planar complexes  $[\text{Ni}(\text{CN})_4]^{2-}$ ,  $[\text{Cu}(\text{NH}_3)_4]^{2+}$ ,  $[\text{PtCl}_4]^{2-}$  (c) octahedral complexes  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{FeF}_6]^{4-}$ ,  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ,  $[\text{CoF}_6]^{3-}$ . Limitations of VBT). 2. Coordination number, coordination geometries of metal ions, types of ligands. 3. Isomerism in coordination compounds, stereo isomerism – (a) geometrical isomerism in (i) square planar metal complexes of the type  $[\text{MA}_2\text{B}_2]$ ,  $[\text{MA}_2\text{BC}]$ ,  $[\text{M}(\text{AB})_2]$ ,  $[\text{MABCD}]$ . (ii) Octahedral metal complexes of the type  $[\text{MA}_4\text{B}_2]$ ,  $[\text{M}(\text{AA})_2\text{B}_2]$ ,  $[\text{MA}_3\text{B}_3]$  using suitable examples, (b) Optical isomerism in (i). tetrahedral complexes  $[\text{MABCD}]$ , (ii). Octahedral complexes  $[\text{M}(\text{AA})_2\text{B}_2]$ ,  $[\text{M}(\text{AA})_3]$  using suitable examples. Structural isomerism: ionization, linkage, coordination ligand isomerism using suitable examples.

**S4-I-2: Organometallic Chemistry**

**4h**

Definition, nomenclature and classification of organometallic compounds. Methods of preparation, properties and applications of alkyl and aryl compounds of Li, Mg & Al. Preparation and properties of ferrocene.

**S4-I-3: Metal carbonyls and related compounds**

**4h**

18 valence electron rule, classification of metal carbonyls:  $\text{Ni}(\text{CO})_4$ ,  $\text{Fe}(\text{CO})_5$ ,  $\text{Fe}_2(\text{CO})_9$ ,  $\text{Fe}_3(\text{CO})_{12}$  and  $\text{Cr}(\text{CO})_6$ , Preparation and properties of  $\text{Ni}(\text{CO})_4$ .

**UNIT - II (Organic chemistry)**

**15 h (1 hr/week)**

**S4-O-1: Carboxylic acids and derivatives**

**6h**

Nomenclature, classification and methods of preparation a) Hydrolysis of Nitriles, amides and esters. b) Carbonation of Grignard reagents. Special methods of preparation of Aromatic Acids. Oxidation of the side chain of Arenes. Hydrolysis of benzotrichlorides. Kolbe reaction. Physical properties- hydrogen bonding, dimeric association, acidity – strength of acids with the examples of trimethyl acetic acid and trichloro acetic acid, Relative differences in the acidity of Aromatic, aliphatic acids & phenols. Chemical properties – Reactions involving H, OH and COOH groups -salt formation, anhydride formation, Acid halide formation, Esterification (mechanism) & Amide formation. Reduction of acid to the corresponding primary alcohol - via ester or acid chloride. Degradation of carboxylic acids by Huns Diecker reaction, Schmidt reaction (Decarboxylation). Arndt – Eistert synthesis, Halogenation by Hell – Volhard - Zelensky reaction. Carboxylic acid Derivatives – Reactions of acid halides, Acid anhydrides, acid amides and esters (mechanism of ester hydrolysis by base and acid).

**S4-O-2: Synthesis based on Carbanions****3 h**

Acidity of  $\alpha$ -Hydrogens of withdrawing groups, structure of carbanion. Preparation of Aceto acetic ester (ethylacetoester) by Claisen condensation and synthetic application of Aceto acetic ester. (a) Acid hydrolysis and ketonic hydrolysis: Butanone, 3-Methyl 2-butanone. Preparation of (i) monocarboxylic acids ii) dicarboxylic acids (b) malonic ester– synthetic applications. Preparation of (i) substituted mono carboxylic acids and (ii) substituted dicarboxylic acids.

**S4-O-3 Nitro hydrocarbons:****6 h**

Nomenclature and classification of nitro hydrocarbons. Structure. Tautomerism of nitroalkanes leading to aci and keto form. Preparation of Nitroalkanes. Reactivity - halogenation, reaction with  $\text{HNO}_2$  (Nitrous acid), Nef reaction, Mannich reaction, Michael addition and reduction. Aromatic Nitro hydrocarbons: Nomenclature, Preparation of Nitrobenzene by Nitration. Physical properties, chemical reactivity – orientation of electrophilic substitution on nitrobenzene. Reduction reaction of Nitrobenzenes in different media.

**Unit – III (Physical Chemistry)****15 hr(1h/week)****S4-P-1: Electrochemistry & EMF****15 h**

Electrical transport – conduction in metals and in electrolyte solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of specific and equivalent conductance with dilution. Migration of ions and Kohlrausch's law, Arrhenius theory of electrolyte dissociation and its limitations, weak and strong electrolytes, Ostwald's dilution law, its uses and limitations. Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only). Transport number, definition and determination by Hittorf's method for attackable electrodes. Applications of conductivity measurements: Determination of degree of dissociation, determination of  $K_a$  of acids, determination of solubility product of a sparingly soluble salt, conductometric titrations.

Electrolyte and Galvanic cells – reversible and irreversible cells, conventional representation of electrochemical cells. EMF of a cell and its measurement. Computation of EMF. Types of reversible electrodes- the gas electrode, metal-metal ion, metal-insoluble salt and redox electrodes. Electrode reactions, Nernst equation, cell EMF and single electrode potential, standard Hydrogen electrode – reference electrodes (calomel electrode) – standard electrode potential, sign conventions, electrochemical series and its significance.

Applications of EMF measurements, Calculation of thermodynamic quantities of cell reactions (  $G$ ,  $H$  and  $K$ ). Determination of pH using hydrogen electrode, glass electrode and quinhydrone electrode, Solubility product of  $\text{AgCl}$ . Potentiometric titrations.

## Unit –IV (General Chemistry)

15 h (1h/week)

### S4-G-1: Pericyclic Reactions

5 h

Concerted reactions, Molecular orbitals of ethene, 1,3-butadiene and allyl radical. Symmetry properties, HOMO, LUMO, Thermal and photochemical pericyclic reactions. Types of pericyclic reactions – electrocyclic, cycloaddition and sigmatropic reactions – one example each and their explanation by FMO theory.

### S4-G-2: Synthetic Strategies

5 h

Terminology – Target molecule (TM), Disconnection approach – Retrosynthesis, Synthons, Synthetic equivalent (SE), Functional group interconversion (FGI), Linear, Convergent synthesis. Retrosynthetic analysis of the following molecules: 1) acetophenone 2) cyclohexene and 3) phenylethylbromide.

### S4-G-3: Asymmetric synthesis

5 h

Definition and classification of stereoselective reactions: substrate, product stereoselective reactions, enantio and diastereo selective reactions. Stereospecific reaction – definition – example – dehalogenation of 1,2-dibromides induced by iodide ion. Enantioselective reactions – definition – example – Reduction of Ethylacetoacetate by Yeast. Diastereoselective reaction – definition – example: Acid catalysed dehydration of 1-phenylpropanal and Grignard addition to 2-phenyl propanal. Definition and explanation of enantiomeric excess and diastereomeric excess.

## References:

### Unit- I

1. Principles of Inorganic Chemistry by Puri, Sharma and Kalia Vishal Publications (1996).
2. Concise Inorganic Chemistry by J.D. Lee 3<sup>rd</sup> edn. Van Nostrand Reinhold Company(1977)
3. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson and Paul.L. Gaus 3<sup>rd</sup> edn Wiley Publishers (2001).
4. Inorganic Chemistry Principles of structure and reactivity by James E.Huhey, E.A. Keiter and R.L. Keiter 4<sup>th</sup> edn. (2006)
5. Chemistry of the elements by N.N.Greenwood and A. Earnshaw Pergamon Press (1989).
6. Inorganic Chemistry by Shriver and Atkins 3<sup>rd</sup> edn Oxford Press (1999).
7. Textbook of Inorganic Chemistry by R Gopalan, Universities Press,(2012)

### Unit- II

1. Text book of organic chemistry by Soni. Sultan Chand & Sons; Twenty Ninth edition (2012)
2. General Organic chemistry by Sachin Kumar Ghosh. New Age Publishers Pvt Ltd (2008)
3. Text book of organic chemistry by Morrison and Boyd. Person(2009)
4. Text book of organic chemistry by Graham Solomons. Wiley(2015)
5. Text book of organic chemistry by Bruce Yuranis Powla. (2012)
6. Text book of organic chemistry by C N pillai CRC Press (2012)

### Unit III

1. Principles of physical chemistry by Prutton and Marron. The Macmillan Company; 4th edition (1970)
2. Text Book of Physical Chemistry by Soni and Dharmahara. Sulthan Chand & sons.(2011)
3. Text Book of Physical Chemistry by Puri and Sharma. S. Nagin chand and Co. (2017)
4. Text Book of Physical Chemistry by K. L. Kapoor. (2012)
5. Physical Chemistry through problems by S.K. Dogra. (2015)
6. Text Book of Physical Chemistry by R.P. Verma.
7. Elements of Physical Chemistry by Lewis Glasstone. Macmillan (1966)
8. Industrial Electrochemistry, D. Pletcher, Chapman & Hall, London, 1990

### Unit IV

1. Text book of organic chemistry by Morrison and Boyd, Person(2009)
2. Text book of organic chemistry by Graham solomons, Wiley(2015)
3. Fundamentals of organic synthesis and retrosynthetic analysis by Ratna Kumar Kar, NCBA,(2014)
4. Organic synthesis by Dr. Jagadamba Singh and Dr. L.D.S. Yadav, Pragati Prakashan, 2010
6. Stereochemistry of organic compounds by D. Nasipuri, New Academic Science Limited, 2012
7. Organic chemistry by Clayden, Greeves, Warren and Wothers, Oxford University Press, 2001
8. Fundamentals of Asymmetric Synthesis by G. L. David Krupadanam, Universities Press(2014)

## Laboratory Course

### Paper IV- Quantitative Analysis - II

45hrs (3h/ week)

1. Conductometry titrations:
  - i) Strong acid Vs Strong base;
  - ii) Weak acid Vs Strong base.
2. Potentiometry titration:
  - i) Strong acid Vs Strong base;
  - ii) Weak acid Vs Strong base.
3. Estimation of Nickel by back titration (Standard  $\text{MgSO}_4$  solution will be given)
4. Estimation of Barium as Barium Sulphate

