



ಕ್ರ. ಸಂ. ಗುಬಿಗು/ವಿಮವಿ/ಬಿಟಿಎಸ್/2016-17/95

ದಿನಾಂಕ: 16/5/16

**ಅಧಿಸೂಚನೆ**

ವಿಷಯ: ರಸಾಯನಶಾಸ್ತ್ರ ಸ್ನಾತಕ/ಸ್ನಾತಕೋತ್ತರ ಕೋರ್ಸಿನ ಎಲ್ಲಾ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಪಠ್ಯಕ್ರಮ ಪರಿಷ್ಕರಿಸಿ ಜಾರಿಗೊಳಿಸಿದ ಬಗ್ಗೆ.

- ಉಲ್ಲೇಖ: 1) ಅಧ್ಯಯನ ಮಂಡಳಿ ಸಭೆಯ ನಿರ್ಣಯ 01 ದಿನಾಂಕ: 17.10.2015.  
2) ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಗೊತ್ತುವಳಿ ಸಂಖ್ಯೆ 15 ದಿನಾಂಕ 27.01.2016.  
3) ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 28.04.2016.

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ಉಲ್ಲೇಖ (2) ರಲ್ಲಿನ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್‌ನ ಸಭೆಯ ಗೊತ್ತುವಳಿ ಸಂಖ್ಯೆ 15 ನ್ನು ಅನುಷ್ಠಾನಗೊಳಿಸುತ್ತ; ರಸಾಯನಶಾಸ್ತ್ರ ವಿಷಯದ ಎಂ.ಎಸ್ಸಿ 1 ರಿಂದ 4 ಹಾಗೂ ಬಿ.ಎಸ್ಸಿ. 1 ರಿಂದ 6ನೇ ಸೆಮೆಸ್ಟರ್‌ನ ಪಠ್ಯಕ್ರಮವನ್ನು ಪರಿಷ್ಕರಿಸಿ, ಸೂಕ್ತ ಬದಲಾವಣೆಗಳೊಂದಿಗೆ ರಸಾಯನಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ಮಂಡಳಿಯು ಅನುಮೋದಿಸಿರುವುದರಿಂದ, ಈ ಪಠ್ಯಕ್ರಮವನ್ನು 2016-17ನೇ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ ಜಾರಿಗೊಳಿಸಲಾಗಿದೆ.

ಮೇಲಿನ ಬದಲಾವಣೆಯನ್ನು ಸಂಬಂಧಪಟ್ಟ ಶಿಕ್ಷಕರ ಹಾಗೂ ವಿದ್ಯಾರ್ಥಿಗಳ ಗಮನಕ್ಕೆ ತರಲು ಸೂಚಿಸಲಾಗಿದೆ. ಪಠ್ಯಕ್ರಮದ ವಿವರವನ್ನು ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯದ ವೆಬ್‌ಸೈಟ್ [www.gulbargauniversity.ac.in](http://www.gulbargauniversity.ac.in) ದಿಂದ ಪಡೆಯಬಹುದು.

  
ಕುಲಸಚಿವರು

ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ

ಗೆ,

- 1) ಮುಖ್ಯಸ್ಥರು, ರಸಾಯನಶಾಸ್ತ್ರ ಅಧ್ಯಯನ ವಿಭಾಗ, ಗು.ವಿ.ಕಲಬುರಗಿ.
- 2) ಎಲ್ಲಾ ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಂಶುಪಾಲರಿಗೆ ಮಾಹಿತಿಗಾಗಿ.

ಪ್ರತಿ:

- 1) ಡೀನ್‌ರು, ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ ನಿಕಾಯ, ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ
- 2) ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ), ಗುಲಬರ್ಗಾ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಕಲಬುರಗಿ.
- 3) ಮುಖ್ಯಸ್ಥರು, ವಿಶ್ವವಿದ್ಯಾಲಯ ಗಣಕ ಕೇಂದ್ರ, ಗು.ವಿ.ಕಲಬುರಗಿ ಇವರಿಗೆ ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ವಿಶ್ವವಿದ್ಯಾಲಯದ ವೆಬ್‌ ಸೈಟ್ ನಲ್ಲಿ ಪ್ರಕಟಿಸಲು ತಿಳಿಸಲಾಗಿದೆ.
- 4) ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿ / ಕುಲಸಚಿವರ ಆಪ್ತ ಸಹಾಯಕರ ಮಾಹಿತಿಗಾಗಿ.

# GULBARGA UNIVERSITY, KALABURAGI



*Department of P.G. Studies  
and Research in Chemistry*

**Revised Syllabus for  
B.Sc. (I-VI) Semester Course in Chemistry  
From Academic Year 2016-17 onwards**



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**GULBARGA UNIVERSITY,  
KALABURAGI  
DEPARTMENT OF CHEMISTRY**

**B.Sc.I to VI semester revised syllabus effective from 2016-2017 onwards**

**B.Sc I and II sem. - From 2016-2017  
B.Sc III and IV sem. - From 2017-2018  
B.Sc V and VI sem. - From 2018-2019**

**FIRST SEMESTER  
CHT : 011 : CHEMISTRY**

<b>UNIT-I : INORGANIC CHEMISTRY</b>	<b>21Hrs.</b>
1. Chemical periodicity	06Hrs.
2. S-block elements	07Hrs.
3. Titrimetric analysis	08Hrs.
<b>UNIT- II : ORGANIC CHEMISTRY</b>	<b>21Hrs.</b>
1. Structure and bonding of organic molecules	05Hrs.
2. Reaction mechanism	07Hrs.
3. Alkanes and cycloalkanes	03Hrs.
4. Alkenes and dienes	06Hrs.
<b>UNIT- III : PHYSICAL CHEMISTRY</b>	<b>22Hrs.</b>
1. Mathematical concepts for chemistry:	04Hrs.
2. Gaseous state	08Hrs.
3. Liquid state	10Hrs.
<b>CHP - 011: LABORATORY COURSE- I</b>	<b>96Hrs.</b>
1. Inorganic Chemistry	
2. Organic Chemistry	
3. Physical Chemistry	

**SECOND SEMESTER  
CHT : 021 : CHEMISTRY**

<b>UNIT- I : INORGANIC CHEMISTRY</b>	<b>21Hrs.</b>
1. P-block elements	09Hrs.
2. Chemical bonding	12Hrs.
<b>UNIT- II : ORGANIC CHEMISTRY</b>	<b>21Hrs.</b>
1. Alkynes	02Hrs.
2. Arenes and aromaticity	07Hrs.
3. Alkyl and aryl halides	05Hrs.
4. Stereochemistry of organic molecules	07Hrs.
<b>UNIT- III : PHYSICAL CHEMISTRY</b>	<b>22Hrs.</b>
1. Thermodynamics - I	08Hrs.
2. Chemical kinetics	09Hrs.
3. Solid state	05Hrs.
<b>CHP - 021: LABORATORY COURSE - II</b>	<b>96Hrs.</b>
1. Organic Chemistry : Qualitative Analysis	
2. Inorganic Chemistry : Calibrations	
3. Physical Chemistry Experiments.	

**THIRD SEMESTER**  
**CHT : 031 : CHEMISTRY**

**UNIT- I: INORGNIC CHEMISTRY**

1. D-block elements :
2. F-block elements:
3. Coordination chemistry:
4. Stability of Metal Complexes:

**UNIT- II : ORGANIC CHEMISTRY**

1. Alcohols
2. Phenols
3. Adehydes and ketones
4. Heterocyclic compounds

**UNIT- III : PHYSICAL CHEMISTRY**

1. Thermodynamics - II
2. Solutions
3. Colloidal state

**CHP : 031: LABORATORY COURSE - III**

1. Inorganic Chemistry - semi-micro analysis of a mixture
2. Organic Chemistry
3. Physical Chemistry

**FOURTH SEMESTER**  
**CHT : 041 : CHEMISTRY**

**UNIT - I : INORGANIC CHEMISTRY**

1. Acids and Bases
2. Non - aqueous Solvents
3. Metal Carbonyls
4. Reactivity of Metal Complexes:

**UNIT- II : ORGANIC CHEMISTRY**

1. Ethers and epoxides
2. Carboxylic acids
3. Acid derivatives
4. Organic compounds of nitrogen

**UNIT- III : PHYSICAL CHEMISTRY**

1. Elementary quantum mechanics
2. Phase equillibria
3. Photochemistry

**CHP - 041: LABORATORY COURSE - IV**

1. Inorganic Chemistry preparations
2. Organic Chemistry estimations
3. Physical Chemistry non-instrumental method of analysis

21Hrs  
03Hrs.  
07Hrs.  
08Hrs.  
03Hrs.  
21Hrs.  
05Hrs.  
05Hrs.  
08Hrs.  
03Hrs.  
22Hrs.  
10Hrs.  
08Hrs.  
04Hrs.  
96Hrs

21Hrs  
05Hrs  
06Hrs  
05Hrs  
05Hrs  
21Hr  
04Hr  
05Hr  
03Hr  
09Hr  
22H  
12H  
05H  
05H  
96H

**FIFTH SEMESTER**  
**CHT : 051 : CHEMISTRY**

<b>UNIT- I: INORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Inorganic polymers	06Hrs.
2. Basic Concepts of Chromatography	07Hrs.
3. Corrosion	03Hrs.
<b>UNIT- II: ORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Spectroscopy	09Hrs.
2. Organometallic compounds	03Hrs.
3. Organosulphur compounds	02Hrs.
4. Rearrangement reactions	02Hrs.
<b>UNIT- III: PHYSICAL CHEMISTRY</b>	<b>16Hrs.</b>
1. Colligative properties	12Hrs.
2. Adsorption	04Hrs.
<b>CHP- 051 : LABORATORY COURSE</b>	<b>48Hrs.</b>

1. Organic Chemistry : Qualitative Analysis of Binary Mixture(Solids)
2. Inorganic Chemistry : Separation of metals and Phenols

**FIFTH SEMESTER**  
**CHT : 052 : CHEMISTRY**

<b>UNIT- I: INORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Bio-inorganic chemistry	08Hrs.
2. Fertilizers	04Hrs.
3. Organic Reagents in Inorganic Analysis	04Hrs.
<b>UNIT- II : ORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Organic synthesis via enolates	03Hrs.
2. Carbohydrates	05Hrs.
3. Oils, fats, soaps and detergents	04Hrs.
4. Synthetic polymers	02Hrs.
5. Synthetic dyes	02Hrs.
<b>UNIT - III : PHYSICAL CHEMISTRY</b>	<b>16Hrs.</b>
1 Electrochemistry	11Hrs.
2. Physical properties and molecular structure	05Hrs.
<b>CHP- 052: LABORATORY COURSE- VI</b>	<b>48Hrs.</b>

1. Physical Chemistry : Instrumental Methods of Analysis – I



**SIXTH SEMESTER  
CHT: 061: CHEMISTRY**

<b>UNIT - I : ANALYTICAL CHEMISTRY</b>	<b>16Hrs.</b>
1. Evaluation of Analytical Data:	06Hrs.
2. Gravimetric Analysis:	08Hrs.
3. Water Analysis:	02Hrs.
<b>UNIT - II :ORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Alkaloids	03Hrs.
2. Terpenes	03Hrs.
3. Amino acids, peptides and proteins	04Hrs.
4. Bio-organic chemistry	06Hrs.
<b>UNIT - III : PHYSICAL CHEMISTRY</b>	<b>16Hrs.</b>
1. Molecular spectroscopy	12Hrs.
2. Radiation chemistry	04Hrs.
<b>CHP- 061: LABORATORY COURSE- VII</b>	<b>48Hrs.</b>
1. Inorganic Chemistry : Gravimetric Estimations.	
2. Organic Chemistry : Preparations.	

**SIXTH SEMESTER  
CHT: 062: CHEMISTRY**

<b>UNIT - I : INDUSTRIAL CHEMISTRY</b>	<b>16Hrs.</b>
1. Cement	06Hrs.
2. Ceramics, Refractories and Glasses	06Hrs.
3. Paints, Pigments and Varnishes	04Hrs.
<b>UNIT - II :ORGANIC CHEMISTRY</b>	<b>16Hrs.</b>
1. Reagents in organic synthesis	05Hrs.
2. Green chemistry	03Hrs.
3. Protections and deprotections	04Hrs.
4. Medicinal Chemistry	04Hrs.
<b>UNIT - III : PHYSICAL CHEMISTRY</b>	<b>16Hrs.</b>
1. Electromotive force	13Hrs.
2. Electrochemical energy sources	03Hrs.
<b>CHP - 062: LABORATORY COURSE- VIII</b>	<b>48Hrs.</b>
1. Physical Chemistry : Instrumental Methods of Analysis – II	

**TEACHING HOURS:**

SEMESTER	THEORY	PRACTICAL
I to IV	6 Hours/week	2×3 Hours /week
V and VI	6 Hours/Week	2×3 Hours/ Week

**SCHEME OF EXAMINATIONS:**

1. There shall be one question paper each for B.Sc. I, II, III and IV semesters in Chemistry Examinations.
2. There shall be two question papers each for B.Sc. V and VI semesters in Chemistry Examinations.
3. In addition there shall be Practical Examinations as per the University Regulations existing from time to time.

**QUESTION PAPER PATTERN:**

Each question paper shall contain three sections (**Section-A**, **Section -B** and **Section -C**)

Answer to all sections shall be written in the same answer book.

**Section-A:**

One compulsory question covering all branches of chemistry of that paper involving **Fifteen** bits. The candidate has to answer all the **Fifteen** bits each bit carry one mark each, with a total of 15 marks of the question.

**Section-B:**

There shall be **six** questions, **two** from each branch, carrying five marks for each question. The candidates has to answer any five questions. The total marks for this section being twenty five.

**Section-C:**

There shall be **six** questions, , **two** from each branch, carrying eight marks for each question. The candidate has to answer any five questions. Total marks for this section being forty.

**SCHEME OF MARKING.**

Each theory paper is of 100 marks.

SEMESTER	THEORY	EXAM. HOURS	MARKS	INTERNAL ASSESSMENT	TOTAL MARKS
I to IV	Paper-I, II, IIIand IV	3 hours	80 marks	20 Marks	100 Marks
V	Paper -V and VI	3 hours	80 marks	20 Marks	100 Marks
VI	Paper-VII and VIII	3 hours	80 marks	20 Marks	100 Marks

**DISTRIBUTION OF MARKS FOR PRACTICAL EXAMINATION:**

Each practical is of 50 marks and of three hours duration.

EXPERIMENT	JOURNAL	VIVA –VOCE	INTERNAL ASSESSMENT	TOTAL MARKS
30Marks	05 marks	05 marks	10 marks	50 marks

**Note:** The internal assessment marks for theory shall be **twenty** and for practicals is **ten**.

**Note:** The candidate should produce the certified journal at the time of each semester examination. In case the candidate fails to submit the certified journal, the laboratory supervisor should give the certificate in this regard. However, no marks shall be given for such certificates.



**FIRST SEMESTER**  
**CHT : 011 : CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

**21Hrs**

**1. Chemical Periodicity**

**06Hrs.**

Introduction, periodic laws, long form of periodic table, cause of periodicity, recurrence of properties classification of elements in to s, p, d and f blocks. Periodic properties- atomic radius, ionic radius, covalent radius, Vander Wall's radius, ionization energy, electron negativity and electron affinity. Variation of the periodic properties along a period and along a group, explanation for the observed trends and factors determining ionization energies

**2. s-block elements:**

**07Hrs.**

Alkali metals: Comparative study of properties of Group 1 elements with respect to their physical properties- electronic configuration, Hardness and softness, melting point and boiling point, density, metallic character, ionization energy, electropositive character, oxidation states, flame colouration. Chemical properties with respect to halides, oxides, super oxides, hydroxides and peroxides.

Alkaline earth metals: Comparative study of properties of group 2 elements with respect to their physical properties- electronic configuration, hardness, softness, densities, melting point and boiling point, metallic character, oxidation states, flame colouration Chemical properties with respect to hydrides, halides, oxides, super oxides, hydroxides and peroxides.

**3. Titrimetric analysis :**

**08Hrs**

Acid base titrations: principle of titrimetric analysis, titration curves for strong acid-strong base, determination of equivalent points and applications for nitrogen, carbonate and bicarbonate,

Redox titrations: Principle, theory, titration curves, redox indicators and applications,

Complexometric titrations: Introduction, titration curves, types of EDTA titrations; applications – hardness of water, magnesium and aluminum in antacid tablet.

Precipitation titrations: Principle, precipitation reactions, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

**UNIT: II : ORGANIC CHEMISTRY**

**21Hrs.**

**1. Structure and bonding of organic molecules:**

**05Hrs.**

Bonding, concept, types of bonds (Ionic, covalent and coordination bonds definition and examples) Bond length, bond angle, and bond energy. Hybridization, types of hybridization ( $sp^3$ ,  $sp^2$  and  $sp$  hybridization by taking methane, ethane and ethyne as examples). Distinction between sigma and pi bonds.

**2. Reaction mechanism:**

**07Hrs.**

Homolytic and Heterolytic bond fission. Electrophiles and nucleophiles -Definition and examples. Reactive intermediates: Definition and formation of Free radicals, carbocations, carbanions and carbenes. Stability of carbocations and carbanions. Electronic effects: Inductive, electromeric, mesomeric and hyperconjugation effect.



Types of organic reactions : Mechanism of  $S_N1$  and  $S_N2$  reaction by taking hydrolysis of t-butyl bromide and methyl bromide as examples. Effect of nature of alkyl groups, nature of leaving groups, nucleophiles and solvents on  $S_N1$  and  $S_N2$  mechanisms.  $E_1$  and  $E_2$  elimination and rearrangement reactions (definition with examples)

**3. Alkanes and cycloalkanes:**

03Hrs.

Isomerism in alkanes up to  $C_5$ , methods of synthesis of alkanes by Wurtz reaction, Kolbe reaction and Corey-House reaction. Cycloalkanes: Nomenclature, synthesis, chemical properties, Baeyer's strain theory and its limitations. Theory of strainless rings.

**4. Alkenes and dienes:**

06Hrs.

Alkenes: Synthesis by dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vicinal dihalides. Chemical reactions- Addition of ozone, halogens and hydrogen halides, Markownikoff's rule and peroxide effect with mechanism and Saytzeff's rule.

Dienes: Methods of synthesis of 1, 3-butadiene, chemical properties- 1, 2- and 1, 4-addition of halogens, hydrogen, hydrogen halides, polymerization and Diels-Alder reaction

**UNIT: III : PHYSICAL CHEMISTRY**

22Hrs

**1. Mathematical Concepts for Chemistry:**

04 Hrs

Logarithmic relations with examples. Exponential and parabolic curves and their applications in chemistry. Curve sketching. Linear graphs and calculation of slopes. Differentiation of functions like  $e^x$ ,  $x^n$ ,  $\log x$ ,  $\sin x$ : Maxima and Minima. Integrations of some useful functions ( $\int e^x$ ,  $\int x^n$ ,  $\int \frac{1}{x}$ ,  $\int \log x$ ). Permutation and combinations. Definitions and examples.

**2. Gaseous state :**

08 Hrs.

Critical phenomenon. PV-isotherm of real gases, continuity of states. The isotherm of carbon dioxide, relationship between critical constants and Vander Waal's constants. The law of corresponding states and reduced equation of state. Molecular velocities: Root mean square velocity, average velocity and most probable velocity problems. Qualitative discussion of Maxwell and Boltzmann's distribution of molecular velocities, collision number, collision diameter and mean free path.

**3. Liquid state :**

10Hrs.

viscosity: Definition, mathematical expression, coefficient of viscosity, effect of temperature, size and weight on it. Determination of viscosity by using Ostwald's viscometer. Numerical problems.

Surface Tension : Definition, mathematical expression, effect of temperature, and solute on it. Problems. Determination of surface tension by using stalagmometer.

Parachor: Definition, Sugden equation. Applications of parachor and refractivity elucidating the structure of benzene molecule.

Refractive index, specific and molar refractivity:

Distribution law: statement, partition coefficient, and condition for validity of distribution law. Thermodynamic derivation. Application - solvent extraction method.



### INORGANIC CHEMISTRY:

1. Estimation of iron in Mohr's salt using  $K_2Cr_2O_7$  as a standard solution.
2. Estimation of copper in copper sulphate solution using sodium thiosulphate as a standard solution.
3. Estimation of potassium permanganate using oxalic acid as a standard solution.
4. Estimation of iron in ferric chloride solution by standard potassium dichromate solution.
5. Estimation of Ferrous and ferric iron in the mixture by using potassium dichromate as standard solution.
6. Estimate the amount of  $H_2SO_4$  and oxalic acid by titrating with NaOH and  $KMnO_4$ .
7. Estimate the amount of calcium in chalk by  $KMnO_4$ .
8. Estimate the amount of NaOH and  $Na_2CO_3$  mixture by standard HCl solution.
9. Estimate the amount of Zn by EDTA solution
10. Estimate the amount of Ca by Standard EDTA solution.
11. Determine the amount of acetic acid in commercial vinegar.

### ORGANIC CHEMISTRY :

Laboratory Techniques.

Calibration of thermometer,

80-82(Naphthalene), 113.5-114(Acetanilide) 132.5-133(Urea), 100 (distilled water)

Determination of melting point,

Naphthalene 80-82, Benzoic acid 121.5-122, Urea 132.5-133,

Succinic acid 184.5-185, Cinnamic 113.5-114, m-Dinitrobenzene 90 P-Dichlorobenzene 52,

Aspirin 135 acid 132.5-133, Salicylic acid 157.5-158, Acetanilide

Determination of boiling points;

Ethanol 78, Cyclohexane 81.4, Toluene 110.6, Benzene 80,

Mixed melting point determination; urea – cinnamic acid mixture in composition (1:4,1:1,4:1)10

Distillation;

Simple distillation of ethanol-water mixture using water condenser, Distillation of nitrobenzene and aniline using air condenser

Sublimation (simple and vacuum); Camphor, Naphthalene, phthalic acid, and succinic acid.

### PHYSICAL CHEMISTRY :

1. Determine the viscosity of two given liquids using Ostwald's viscometer (densities are given)
2. Determine the viscosity of a given liquid using Ostwald's viscometer and determine the density of given liquid
3. Determine the percentage composition of given liquid mixture (glycerol and water) using Ostwald's viscometer
4. Determine the surface tension of a given liquid sample/compound using stalagmometer



- and determine the density of liquid.
- Determine the surface tension of two given liquids using stalagmometer and calculate the Parachor (densities of liquids are given)
  - Determine the percentage composition of liquid mixture by S.T. method (eg. ethyl alcohol+water and benzene+nitrobenzene)

Note: Either inorganic estimations or Physical chemistry experiment is given in the examination (by lot).

**SECOND SEMESTER**  
**CHT : 021 : CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

**21Hr**  
**09Hrs.**

**1. p-block elements :**

Compounds of Boron : Preparation, properties, structure and uses of borazole, diborane and boron trifluoride  
 Carbon Family: Structure and properties of graphite and diamond. Preparation, properties and uses of fluorocarbons and teflon.  
 Halogens: Interhalogens - Preparation, properties. Structure and uses of interhalogens of the type AB, AB<sub>3</sub>, AB<sub>5</sub> and AB<sub>7</sub>.  
 Pseudo halogens - Preparation and properties of cyanogen, thiocyanogen and selenocyanogen.

**2. Chemical Bonding:**

**12Hrs.**

Ionic bond: Lattice energy, Born-Haber cycle, Born-Landé equation (derivation not required, problems on Born-Landé expression to be worked out). Calculation of lattice energies of NaCl and MgO, effect of lattice energy on solubility of ionic compounds.  
 Covalent Bond: Valence bond approach- hybridization and directional characteristics of sp, sp<sup>2</sup>, sp<sup>3</sup>, sp<sup>2</sup>d, sp<sup>3</sup>d<sup>2</sup>. Shapes of BeCl<sub>2</sub>, BF<sub>3</sub>, SiCl<sub>4</sub>, PCl<sub>5</sub>, SF<sub>6</sub>. VSEPR theory: shapes of CH<sub>4</sub>, NH<sub>3</sub>, NH<sub>4</sub><sup>+</sup>, H<sub>2</sub>O, BrF<sub>3</sub>, ICl<sub>2</sub><sup>-</sup>.  
 Molecular orbital theory: H<sub>2</sub>, He<sub>2</sub><sup>+</sup>, Be<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, O<sub>2</sub><sup>-</sup>, O<sub>2</sub><sup>2-</sup>, O<sub>2</sub><sup>+</sup> and CO (bond order, stability and magnetic properties to be discussed). Polarization concept, Fajan's rule, bond length, bond angle and bond energy, polar and non-polar molecules, dipole moment. Weak interactions:  
 Hydrogen bond: Intra molecular and Intermolecular types, anomalous properties of HF, H<sub>2</sub>O, NH<sub>3</sub>, alcohols, carboxylic acids, nitro phenols and bio molecules.  
 Metallic bond: Definition, characterization of metallic states, electron Sea Model.

**UNIT: II : ORGANIC CHEMISTRY**

**21 Hrs**  
**02 Hrs**

**1. Alkynes:**

Alkynes- Synthesis by dehydrohalogenation of vicinal dihalides, dehalogenation of tetra halides. Acidity of alkynes, chemical reactions of alkynes-Addition of halogen acids, water, formation of metal acetylides. Synthesis and uses of chloroprene.

**2. Arenes and aromaticity:**

**07 Hrs**

Arenes: Nomenclature of benzene derivatives, modern concept of structure of benzene including M.O.T. Resonance energy, Mechanism of electrophilic substitution reaction of benzene – Nitration, Halogenation, Sulphonation and Friedel - Craft's reaction. Effect of substitution on mono substituted benzene- o, p- orienting groups ( explain by taking



electron donor groups), m-orienting groups (explain by taking electron withdrawing groups) and anomalous behaviour of -chlorine.

Aromaticity- Definition, criteria, Huckel's rule.

### 3. Alkyl and aryl halides :

05Hrs.

Alkyl halides - Nomenclature, classification with examples, methods of formation and reaction with mechanisms

Aryl halides - Methods of formation, nucleophilic displacement reactions with NaOH,  $\text{NH}_3$ , KCN, Ullmann reaction, Wittig reaction and Wurtz-Fittig reaction ( $\text{C}_6\text{H}_5\text{Cl}$  is taken as an example)

### 4. Stereochemistry of organic molecules:

07Hrs.

Concepts of isomerism, stereoisomerism and types,

Geometrical isomerism- Definition Geometrical isomerism in maleic and fumaric acids.

Cis and trans system of nomenclature.

Optical isomerism – Optical activity, chiral carbon, elements of symmetry, Optical isomerism in compounds with i) one chiral carbon Ex. lactic acid and 2-chloro butane and ii) two chiral carbon Ex. tartaric acid and 2-bromo-3-chloro butane;

Enantiomers and diastereomers, R and S system of nomenclature.

## UNIT: III: PHYSICAL CHEMISTRY

22Hrs.

### 1. Thermodynamics - I:

08Hrs.

Revision of basic terms, First law of thermodynamics, statement, definition of internal energy and enthalpy, mathematical form of first law.

Calculation of  $w$ ,  $q$ ,  $dU$ ,  $dH$ , for the expansion of ideal gas under isothermal and adiabatic conditions for reversible process. Molar heat capacities of gases at constant volume and at constant pressure and relation between them. Numerical problems. Joule Thomson effect, Joule Thomson co-efficient, inversion temperature. Zeroth law of thermodynamics. Absolute scale of temperature.

### 2. Chemical kinetics:

09Hrs.

Revision of the concepts, the rate, order and molecularity of reaction and Half life period. Second order reactions with examples. Derivation of specific rate constant of a second order reaction when  $a=b$ . Methods of determination of order of a reaction -differential, half life and graphical method. Theory of reaction rates- qualitative treatment of collision theory of bimolecular reactions. Theory of unimolecular reactions (Lindmann's hypothesis and steady state principle). An elementary account of transition state theory, activated complex its relation with thermodynamic functions ( $\Delta G^\ddagger$ ,  $\Delta H^\ddagger$  and  $\Delta S^\ddagger$ ), Parallel reactions with examples, consecutive reactions with examples. Numerical problems of second order reactions.

### 3. Solid state:

05Hrs.

Crystalline state, laws of crystallography (definition and explanation), symmetry on cubic crystal systems : Plane of symmetry, axis of symmetry, center of symmetry. Weiss and Miller Indices, derivation of Bragg's equation. Problems.

Nano particles: - Introduction, definition of nano particles. Classification of nano particles into dimensions ([0],[1],[2]). Structures of carbon nano tubes. Applications of nano particles



**Organic Chemistry:**

Organic qualitative analysis of single compound. Identification of an organic compound through nature of compound, physical constant, elemental analysis, functional group analysis and preparation of suitable derivatives.

Carboxylic acids: Benzoic acid, Cinnamic acid, Salicylic acid and Phthalic acid.

Phenols: Phenol, Cresols, 1-Naphthol and 2-Naphthol

Aldehydes : Benzaldehyde.

Ketones: Ethylmethylketone, Acetophenone and Acetone

Esters: Ethyl acetate

Hydrocarbon: Naphthalene and Diphenyl

Amine: Aniline and Toluidines.

Nitro compounds: Nitrobenzene and m-Dinitrobenzene

Analides: Acetanilide

Halogen compounds: Chlorobenzene and Bromobenzene

**Inorganic Chemistry:**

Calibration of fractional weights, pipettes and burettes.

Preparation of standard solutions, dilution - 0.2M to 0.001M solutions

**Physical Chemistry :**

Thermo chemistry.- To determine the solubility of benzoic acid at different temperatures and to determine  $\Delta H$  of the dissolution process.

To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalph data using Born Hber cycle.

*Note:-* Only organic analysis is to be given for the examination.

**THIRD SEMESTER**  
**CHT : 031 : CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

**21Hrs.**

**1. d-Block Elements :**

**03Hrs.**

Introduction, comparative study of properties of transitional elements of 3d- series with respect to electronic configuration, oxidation states, atomic volume and densities, atomic and ionic radius, melting point and boiling points, ionization energy, colour characteristic properties, magnetic properties, catalytic activity, interstitial compound formation and complex forming ability.

**2. f-Block Elements:**

**07Hrs**

Lanthanides-Introduction, electronic configuration, oxidation states, atomic and ionic radii, colour characteristic properties, magnetic properties and complex forming ability of lanthanides. Lanthanide contraction-causes for it and its consequences. Separation of lanthanides by ion exchange method.

Actinides-Introduction, electronic configuration, oxidation states, atomic and ionic radii, colour characteristic properties, magnetic properties and complex forming ability of actinides. Actinide contraction. Similarities and differences between lanthanides and actinides.

**3. Coordination Chemistry:**

**08Hrs.**

Introduction, definition of the terms, ligands, donors, acceptors, coordination sphere, coordination number. Types of ligands, nomenclature of coordination compounds, Werner's theory of coordination compounds, Sidgwick theory and EAN rule, stereoisomerism of complexes of coordination number 4 and 6.

**VBT-** Postulates and limitation of valence bond theory, structure and bonding of  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{4-}$ ,  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ ,  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  and  $[\text{Ni}(\text{CO})_4]$ , explanation of outer and inner orbital complexes with examples.

**CFT-**Postulates, splitting of d-orbital in square planar and octahedral complexes, low Spin and high spin complexes, CFSE and elementary treatment.

**4.Stability of Metal Complexes:**

**03Hrs.**

Thermodynamic stability and kinetic stability, factors affecting the stability of metal complexes, chelate effect, determination of composition of complex by Job's method and mole ratio method.

**UNIT: II : ORGANIC CHEMISTRY**

**21Hrs.**

**1. Alcohols :**

**05Hrs.**

Classification with examples, nomenclature (IUPAC), Methods of synthesis of alcohols (by hydration of alkenes, reduction of aldehydes and ketones, addition of  $\text{RMgX}$  to aldehydes and ketones). Distinguishing test for primary, secondary and tertiary alcohols by dehydration and Lucas method. Mechanism of esterification reaction between ethyl alcohol and acetic acid.

Dihydric alcohols: Methods of formation of ethylene glycol, mechanism of Pinacol-pinacolone rearrangement.



## 2. Phenols :

05Hrs.

Classification with example, manufacture of phenol by cumene and Dow process. Acidity of phenol, mechanism of Reimer Tiemann and Kolbe reactions. Reactions of phenol- conversion of phenol into 1 Aspirin 2. Methyl salicylate 3. Salol, 4. Picric acid 5. Phenolic ketones (Fries rearrangement) 6. Phenolphthalein.

## 3. Aldehydes And Ketones :

08Hrs.

Nomenclature (IUPAC) of aliphatic aldehydes and ketones, general methods of preparation by alcohols, gem dihalides, alkynes and calcium salt of fatty acids (acetaldehyde and acetone may be taken as examples). Mechanism of nucleophilic addition with HCN and condensation reaction with ammonia derivatives  $R-NH_2$  ( $R = -OH, -NH_2, -NHPh$ ) of aldehydes and ketones. Mechanism of aldol condensation with acetaldehyde, Wittig reaction, Mannich reaction, Baeyer- Villiger oxidation of ketones, Wolf- Kishner reduction.

Aromatic aldehydes; Mechanism of Benzoin condensation reaction and Cannizzaro's reaction (benzaldehyde is taken as example).

## 4. Heterocyclic Compounds :

03Hrs.

Definition and classification, methods of synthesis of furan, thiophene pyrrole and pyridine. Aromatic character of the above compounds (with molecular orbital picture). Electrophilic substitution reactions of pyrrole and pyridine

## UNIT: III : PHYSICAL CHEMISTRY

22Hrs.

### 1. Thermodynamics - II :

10Hrs.

Limitation of First law (need of second law). Spontaneous process

With examples. Different statements of second law of thermodynamics. Carnot's cycle, efficiency of the heat engine, Carnot's theorem, concept of entropy, entropy as a state function, physical significance of entropy, entropy changes of an ideal gas with changes in  $P$ ,  $V$  and  $T$ , calculation of entropy changes in reversible, isothermal and reversible adiabatic process. Problems based on efficiency equation.

Gibb's and Helmholtz free energy functions, Gibb's free energy function - useful work, significance of free energy change - criteria for spontaneity and equilibria in terms of  $U, H, S, A$  and  $G$ . Derivation of Gibb's Helmholtz equation. Clapeyron - Clausius equation and its applications. Third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy.

### 2. Solutions :

08Hrs.

Different types of solutions with examples. Binary mixture of completely miscible liquids, Raoult's law. Ideal and nonideal solutions (based on Raoult's law), positive and negative deviations from Raoult's law with examples. Vapour pressure - composition and boiling point-composition diagrams for above types. Principle of fractional distillation, Azeotropic mixtures. Partially miscible liquid mixtures, critical solution temperature (CST) with respect to (a) water- phenol system (b) triethylamine - water system and (c) Nicotine - water system. Effect of addition of salt on CST of phenol water system. Immiscible liquid - steam distillation and applications.

### 3. Colloidal State :

04Hrs.

Concepts, electrical properties of sols, origin of charge on colloidal particles, theory of electric double layer. Zeta potential, electro-osmosis, electrophoresis, general applications of colloids.

Emulsions - types, preparations, emulsifying agent and applications  
Gels - classification, preparation and applications

**CHP: 031: LABORATORY COURSE- III**

**96Hrs.**

**Inorganic Chemistry :**

Inorganic semi-micro qualitative analysis containing two anions and two cations

Acid radicals:-  $\text{CO}_3$ ,  $\text{C}_2\text{O}_4$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ , and  $\text{SO}_4^{2-}$

Basic radicals:-  $\text{Cu}^{+2}$ ,  $\text{Bi}^{+3}$ ,  $\text{Cd}^{+2}$ ,  $\text{Co}^{+2}$ ,  $\text{Al}^{+3}$ ,  $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$ ,  $\text{Zn}^{+2}$ ,  $\text{Ca}^{+2}$ ,  $\text{Sr}^{+2}$ ,  $\text{Ba}^{+2}$ ,  $\text{Mg}^{+2}$ ,  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{NH}_4^+$ .

**Organic chemistry:**

Crystallization, Concept of induction of crystallization, Phthalic acid from hot water (using fluted filter paper and stem less funnel), Acetanilide from boiling water, Naphthalene from ethanol

Benzoic acid from water, Decolourisation and crystallization using charcoal

Decolourisation of brown sugar (sucrose) with animal charcoal using gravity filtration

Crystallization and decolourisation of impure naphthalene (100g of naphthalene mixed with 0.3g of Congo red using 1g decolorizing carbon) from ethanol.

**Physical chemistry:**

1. To prepare arsenious sulphide solution and compare the precipitating power of mono, bi and trivalent anions.
2. Determination of transition temperature of the given substance by thermometric/ dilatometric method (e.g.  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$  or  $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$ )
3. To construct the Phase diagram of two component (e.g. diphenylamine benzophenone) system by cooling curve method.

Note:-Only inorganic semi micro qualitative analysis is given in the examination.



**FOURTH SEMESTER**  
**CHT : 041 : CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

**21Hrs.**

**1. Acids and Bases:**

**05Hrs.**

Definition of acids and bases, Arrhenius theory, Lowry-Bronsted theory, Lewis concept and Lux-Flood theory. HSAB principle and applications

**2. Non - aqueous Solvents:**

**06Hrs.**

Introduction, physical properties of a solvent, types of solvents and their general characteristics. Reaction in nonaqueous solvents with reference to liquid ammonia, liquid sulphur dioxide, liquid  $\text{H}_2\text{SO}_4$  and  $\text{N}_2\text{O}_4$ .

**3. Metal Carbonyls:**

**07Hrs.**

Preparation, properties, structure and bonding of mononuclear carbonyls with reference to  $\text{Fe}(\text{CO})_5$ ,  $\text{Ni}(\text{CO})_4$  and  $\text{Cr}(\text{CO})_6$ ,  $\pi$ -acceptor behavior of carbon monoxide, synergic effect (MO diagram of CO). Carbonylate anions, ferrocene and its reactions.

**4. Reactivity of Metal Complexes:**

**03Hrs.**

Labile and inert complexes, ligand substitution reactions –  $\text{SN}^1$  and  $\text{SN}^2$ , substitution reactions of square planar complexes – Trans effect and its applications.

**UNIT: II : ORGANIC CHEMISTRY**

**21Hrs**

**1. Ethers and Epoxides :**

**04Hrs.**

Definition, nomenclature, methods of preparation by dehydration of alcohols, Williamson's ether synthesis, heating alkyl halide with dry silver oxide. Reactions- auto oxidation and C-O bond cleavage reactions.

Crown ether: Introduction with example.

Epoxides: Definition and synthesis of Epoxide (ethylene oxide as an example) acid and base catalyzed ring opening reactions.

**2. Carboxylic Acids :**

**05Hrs.**

Definition, classification with examples, methods of synthesis of fatty acids by alcohols, cyanides and Grignard reagent. Acidity of carboxylic acids, effect of substitution on acid strength. Compare acid strengths among: formic acid, acetic acid, propanoic acid, benzoic acid chloro, fluoro, bromoacetic acids acetic acid, mono, di, and trichloroacetic acids, Hell-Volhard-Zelinsky reaction of carboxylic acids.

Di-carboxylic acids (aliphatic); General methods of synthesis of di-carboxylic acids from cyclic ketones and cyanides.

**3. Acid Derivatives :**

**03Hrs.**

Definition with examples, synthesis of acidchlorides (acetyl chloride) and reactions (hydrolysis, alcoholysis, ammonolysis, reduction, Rosenmund reduction, Friedel Crafts acylation; Acid anhydrides (acetic anhydride) reactions (hydrolysis, reaction with alcohol, ammonia); Amides (acetamide) reactions (hydrolysis, reduction, Hoffmann degradation, action of nitrous acid)

**4. Organic Compounds of Nitrogen :**

**09Hrs.**

Nitro compounds: General methods of preparation of nitroalkanes and nitro arenes, reduction of nitrobenzene in acid, alkaline and neutral medium. Electrophilic substitution reactions of nitrobenzene.



Amines: Definition, classification with examples. General methods of synthesis of aliphatic and aromatic primary amines (methyl amine and aniline).

Distinguishing tests for primary, secondary, tertiary amines by the action of nitrous acid and benzene sulphonylchloride. Basic character of amines.

- $\text{CH}_3\text{NH}_2$ ,  $(\text{CH}_3)_2\text{NH}$  &  $(\text{CH}_3)_3\text{N}$
- $\text{C}_6\text{H}_5\text{NH}_2$ ,  $\text{C}_6\text{H}_5\text{NHCH}_3$  and  $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$
- Aniline, P-nitro aniline and P-Toluidine

Preparation, structure and synthetic applications of Benzene diazonium chloride.

Sandmeyer's reaction. (Conversion to chlorobenzene, bromobenzene and benzonitrile), reduction (to phenyl hydrazine), coupling reactions to give azo dyes (p-hydroxyazobenzene and p-dimethylaminoazobenzene)

### UNIT: III: PHYSICAL CHEMISTRY

22Hrs.

#### 1. Elementary Quantum Mechanics :

12Hrs.

Review of Bohr's atomic model. Limitations of classical mechanics. Wave particle duality. Postulates of quantum mechanics. Black body radiation, Planck's radiation law, photoelectric effect, Compton Effect, De-Broglie hypothesis. The Heisenberg's uncertainty principle, Hamiltonian operator, Schrödinger wave equation and its importance, Physical interpretation of the wave function. (Significations of  $\psi$  and  $\psi^2$ ). Schrödinger wave equation for H-atom, separation in to three equations (without derivation) general explorations of radial wave function and angular wave function. Quantum numbers and their importance (only qualitative).

#### 2. Phase Equilibria:

05Hrs.

Phase rule, definition and explanation of the terms involved in the phase rule. Application to one component system (water and sulphur), triple point, application to two component system (lead-silver and potassium iodide-water system), Eutectic mixtures and their applications. Freezing mixtures. Desilverization of lead by Pattinson's method.

#### 3. Photochemistry:

05Hrs.

Interaction of radiation with matter, difference between thermal and photochemical process, laws of photochemistry, Grothus-Draper's law, Beer-Lambert's law, Stark Einstein's law of photochemical equivalence, quantum yield. quantum yield of photochemical combination of a).  $\text{H}_2$  and  $\text{Cl}_2$  b).  $\text{H}_2$  and  $\text{Br}_2$  c). dissociation of  $\text{HI}$ . Qualitative description of fluorescence, phosphorescence, luminescence, photosensitized reactions with examples.

### CHP : 041: LABORATORY COURSE- IV

96Hrs.

#### Inorganic Chemistry:

##### 1. Synthesis and Analysis:

- Preparation of sodium trioxalato ferrate(III) and determine the composition by permanganometry.
- Preparation of Ni-DMG complex
- Preparation of copper tetra amine complex
- Preparation of cis and trans-bisoxalatodiaquachromate(III) ion.

##### 2. Instrumentation : Colorimetry –

- Determination of iron using 1, 10- phenanthroline as a reagent by colorimetry.
- Determination of the composition of the above complex by Job's method and



mole ratio method.

### 3. Water and Effluent analysis.

#### Organic Chemistry:

##### Estimations:

1. Estimation of water soluble carboxylic acid-titration method
2. Estimation of glucose by titrimetry method
3. Estimation of phenol /aniline by bromination method
4. Estimation of Aldehyde and ketone
5. Estimation of amino acid
6. Estimation of vitamin-C by titrimetry method
7. Estimation of Nitrogen by Kjeldahl method.

#### Physical Chemistry:

##### Non-instrumental Methods of analysis :

1. Determine the specific rate constant of hydrolysis of methyl acetate by HCl at room temperature.
2. Compare the strength of HCl and  $H_2SO_4$  in the hydrolysis of ethyl acetate (k for one acid is given)
3. Determine the activation energy in the hydrolysis of methyl acetate (k value For one Temperature is to be given)
4. Determine the partition coefficient of iodine between carbon tetrachloride and water.
5. Determine the equilibrium constant of  $KI + I_2 = KI_3$  by distribution law method.
6. study the adsorption of acetic acid by activated charcoal
7. Determine the specific rate constant of a second order reaction between  $K_2I_2O_8$  and  $K_2S_2O_8$
8. Determine the specific rate constant of saponification of ethyl acetate by sodium hydroxide
9. Determine the critical solution temperature of water – phenol system
10. Determine the percentage of NaCl solution using solubility of phenol in water.
11. Determine the molecular weight of non volatile solute by Rast method
12. Determine the molecular weight of non volatile solute by ebullioscopy method.
13. Determine the heat of neutralization of strong acid and strong base.
14. Determine the heat of neutralization of acetic acid and sodium hydroxide and calculate
15. the heat of ionization of acetic acid.

Note:- Either organic estimations or physical experiments is to be given for Examination

**FIFTH SEMESTER**  
**CHT : 051 : CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

**16Hrs.**

**1. Inorganic Polymers :**

**05Hrs.**

Definition, types of inorganic polymers, classification, comparison between organic and inorganic polymers. Synthesis, structural aspects and applications of silicones, Phospha-ozenes and phosphonitrilic chlorides.

Classification and structure of silicates - orthosilicates, pyrosilicates, polysilicates, cyclosilicates, chainsilicates and sheetsilicates.

**2. Basic Concepts of Chromatography:**

**08Hrs.**

General description, definitions, terms and parameters used in chromatography. Classification of chromatographic methods. Criteria for selection of a stationary and mobile phase-nature of adsorbents, factors influencing the adsorbents, nature and types of mobile phases.

Thin layer Chromatography (TLC): Principle, methodology, determination of  $R_f$  value and its significance, variables that affect  $R_f$  value and applications.

Paper chromatography (PC): Definitions, theory and principle, techniques: one, two-dimensional and circular PC, mechanism of separation, structure of cellulose and types of paper, methodology, factors affecting  $R_f$  value, advantages and applications.

Gas chromatography (GC): Basic Principle, instrumentation and applications.

**3. Corrosion :**

**03Hrs.**

Definition, theories, reactions, factors affecting corrosion rate, prevention and protective coatings.

**UNIT: II : ORGANIC CHEMISTRY**

**16Hrs.**

**1. Spectroscopy :**

**09Hrs.**

Introduction, advantage of spectroscopic methods. Principle, instrumentation and applications of UV-VIS, IR, FTIR, NMR spectroscopy in organic analysis. Meaning of the terms chromophore, auxochrophore, bathochromic and hypsochromophoric shifts with examples. Functional group and fingerprint regions, types of vibrations and groups frequencies and their region of absorptions. Equivalent and non-equivalent protons, chemical shift, spin-spin coupling,  $(n+1)$  rule, Shielding and deshielding of protons in NMR spectroscopy. NMR spectra of simple organic molecules such as Ethyl bromide, Ethanol, Acetaldehyde and Toluene

**2. Organometallic Compounds :**

**03Hrs.**

The Grignard reagent : synthesis and application of methyl magnesium iodide. Reformatsky reaction

**3. Organo Sulphur Compounds :**

**02Hrs.**

Nomenclature, methods of formation and chemical reactions of thiols (Ethane thiol may be taken as example).

Thioethers- Nomenclature, methods of preparation and chemical reactions (Diethyl sulphide may be taken as example).



4. **Rearrangement reactions :** 02Hrs.  
Backmann, Lossen and Curtius, dienone and Benzidine rearrangements.

**UNIT: III : PHYSICAL CHEMISTRY 16Hrs**

1. **colligative properties :** 12 Hrs  
Definition and examples

Osmosis and Osmotic Pressure: Semi permeable membrane, natural and artificial semi permeable examples. Osmosis and osmotic pressure- determination of osmotic pressure by Berkeley and Hertley's method. Theory of dilute solutions. Laws of osmotic pressure, relationship between molecular mass and osmotic pressure, isotonic solutions. Numerical problems

Lowering of vapour Pressure : Concept of vapour pressure, Raoult's Law, relative lowering of vapour pressure of solvent, its determination by dynamic method (Oswald's & Walker). Calculation of molecular mass from relative lowering of vapour pressure. Problems

Elevation in boiling point: definition and its relationship with relative lowering of vapour pressure (to be derived from Clepeyron-Clausius equation). Ebullioscopic constant of solvent, relationship between molar mass and elevation in boiling point. Determination of molar mass of solute by Land Berger's method. Problems.

Depression in freezing point: Definition and its relationship to the lowering of vapour pressure, cryoscopic constant of the solvent, relation between depression in freezing point and molecular mass of solute (to be derived from Clepeyron- Clausius equation), determination of molecular mass of solute by cryoscopic method. Problems

2. **Adsorption :** 04Hrs.

Adsorption of gases by Solids: Adsorption isotherms, derivation of Frundlich adsorption isotherm and its limitations. Derivation of Langmuir's adsorption isotherms, BET equation (no derivation) and its application in the determination of surface area of adsorbent. Applications of adsorption

**CHP :051: LABORATORY COURSE 48 Hrs**

**Organic Chemistry:**

Qualitative analysis of binary mixture containing two solid compounds, separation using  $\text{NaHCO}_3$ ,  $\text{NaOH}$  and  $\text{HCl}$ . Identification of mixture, separation of mixture and analysis of any one component with preparation of derivative.

Acids-Benzoic, Salicylic, Cinnamic and phthalic acid.

Phenols:- 1-Naphthol, 2-Naphthol and resorcinol.

Bases:-P-Toluidine, O-Toluidine, m-Toluidine, Nitro anilines

Neutral:-Naphthalene, Diphenyl, m-dinitrobenzene, Acetanilide.

The mixture is of A+B, A+N, P+B, P+N and B+N

**Inorganic Chemistry:**

1. Separation of metal ions of group IV by ascending chromatography.

2. Separation of metal ions of group II by paper chromatography.

3. Separation of Phenols on activated silica gel (tlc).

Note : Qualitative analysis is given in the examination.



**FIFTH SEMESTER**  
**CHT: 052: CHEMISTRY**  
**UNIT: I : INORGANIC CHEMISTRY**

16Hrs.

**1. Bioinorganic Chemistry:**

08Hrs.

Introduction, essential and trace elements, non-essential elements, role of Na, K, Mg, Ca, Fe, Co, Ni, Cu and Zn in biological systems. Metalloporphyrins with special reference to haemoglobin, myoglobin and chlorophyll-structure and their functions. Role of cobalamine (vitamin B<sub>12</sub> coenzyme) in living system. Chemical Toxicology: Toxic chemicals in the environment; impact of toxic chemicals on enzymes; biochemical effect of As, Cd, Pb and Hg.

04Hrs.

**2. Fertilizers:**

Introduction (need of fertilizers), functions of essential plant nutrients (N,P,K), Classification of fertilizers with examples. Nitrogenous, Phosphatic and mixed fertilizers with suitable examples. Nitrogen fixation. Manufacture of urea and Super phosphate of lime, and their uses. Fertilizer industries in India.

04Hrs.

**3. Organic Reagents in Inorganic Analysis:**

Introduction, advantages and disadvantages of organic reagents. Structure and applications of oxine, dimethyl glyoxime,  $\alpha$ -nitroso- $\beta$ -naphthol, cupferon and aluminon.

**UNIT: II : ORGANIC CHEMISTRY**

16Hrs.

**1. Organic Synthesis Via Enolates :**

03Hrs.

Reactive Methylene compounds: Acidity of alpha hydrogen atoms. Synthesis of ethyl acetoacetate (mechanism of Claisen condensation). Keto-enol tautomerism in ethyl acetoacetate. Synthetic applications of ethyl acetoacetate. Synthesis of alkylacetic acid, succinic acid and crotonic acid, acetyl acetone, 4-methyl uracil and antipyrine..

05Hrs.

**2. Carbohydrates :**

Introduction and classification. Mechanism of osazone formation, Inter conversion of Glucose into Fructose and vice-versa. Chain lengthening of aldoses ( Killiani-Fischer synthesis), chain shortening of aldoses (wohl degradation). Epimerization and mutarotation. Elucidation of structure of glucose (open chain structure and configuration). Determination of ring size in glucose (Fischer and Haworth structure of glucose). Haworth structure of sucrose, maltose, lactose

04Hrs.

**3. Oils, Fats , Soaps And Detergents :**

Composition of oils and fats. Determination of saponification value and iodine value of oils and fats. Manufacture of soaps (hydrolyser process). Synthetic detergents (Syndets) manufacture of sodium lauryl sulphate and sodium do decyl benzene sulphonate. Cleansing action of soaps.

02Hrs.

**4. Synthetic Polymers :**

Classification with examples, synthesis and uses of low density and high density polyethene, poly vinyl chloride, nylon 6, nylon 6,6, bakelite and terylene.



### 5. Synthetic Dyes :

02Hrs.

Introduction, classification based on structure, chromophore theory of colour and constitution, Synthesis of congo red, bismarck brown, malachite green and alizarin.

## UNIT: III : PHYSICAL CHEMISTRY

16Hrs.

### 1. Electrochemistry :

11Hrs.

Revision of conduction in metals and electrolyte solutions, Specific conductance, molar conductance, equivalent conductance, variation of equivalent conductance and specific conductance with dilution. Cell constant, determination of equivalent conductance. Ionic conductance, ionic mobility, Kohlrausch's and its applications. Numerical problems. Hittroff's theoretical device, transport number, determination of transport number by Hittroff's method (non-attackable electrodes). Debey-Huckel-Onsagar equation for strong electrolytes (elementary treatment only)

Application of conductance measurements

- Solubility and solubility product of sparingly soluble salt
- Degree of dissociation of weak electrolytes
- Conductometric titrations-acid-base and precipitation titrations and advantages of these

### 2 Physical properties and molecular structure :

05Hrs.

Dipole moment, polarization, induced polarization, orientation polarization, measurement of dipole movement by temperature method. Classius - Mossotti equation and its importance. Dipole movement and structure of Molecules ( $\text{CO}_2$ ,  $\text{H}_2\text{O}$ ,  $\text{BF}_3$ ,  $\text{NH}_3$  and  $\text{CCl}_4$ )

Magnetic Properties : Paramagnetic diamagnetic and ferromagnetic systems

## CHP : 061<sup>052</sup> : LABORATORY COURSE -VI

48Hrs.

### Physical Chemistry:

#### Instrumental methods of analysis - I

- Conductometric titration of strong acid (say  $\text{HCl}$ ) against strong base ( $\text{NaOH}$ )
- Conductometric titration of weak acid (acetic acid) against strong base ( $\text{NaOH}$ )
- Conductometric titration of mixture of acids against strong base
- Conductometric precipitation titration of sodium chloride against silver Nitrate
- Determination of amount of  $\text{Cu}^{+2}$  in  $\text{CuSO}_4$  solution and verify Beer Lambert's law.
- Determine the specific and molar refractivity of two given liquids by Abbe refractometer and determine the densities of two given liquids.
- Estimation of  $\text{HCl}$  by titrating with standard  $\text{NaOH}$  potentiometrically.
- Estimate the amount of iron in ferrous ammonium sulphate by titrating with std. Potassium dichromate solution potentiometrically.
- Potentiometric titration of dibasic acid with strong base.
- Determination of amount of sodium chloride in the given solution potentiometric titration against silver nitrate
- Determine the specific rotation of cane sugar solution using polarimeter.



**SIXTH SEMESTER**  
**061 CHT: 062: CHEMISTRY**

**UNIT : I : ANALYTICAL CHEMISTRY** **16Hrs.**

**1. Evaluation of Analytical Data:**

06Hrs.

Introduction, Error, Accuracy, precision, methods of expressing accuracy and precision, classification of errors, significant figures and computations, distribution of random errors, mean and standard deviations, reliability of results. Methods of reporting analytical data.

**2. Gravimetric Analysis:**

07Hrs.

General principles, stoichiometry, calculation of results from gravimetric data. Properties of precipitates. Nucleation and crystal growth, factors influencing completion of precipitation, co-precipitation and post-precipitation, purification and washing of precipitates. Precipitation from homogeneous solution, a few common gravimetric determinations-chloride as silver chloride, sulphate as barium sulphate, aluminium as the oxinate and nickel as dimethyl glyoximate.

**3. Water Analysis:**

03Hrs.

Sampling and preservation of water. Determination of hardness, alkalinity, acidity, total dissolved solids (TDS), Dissolved oxygen (DO) – by Winkler's method and domestic waste water treatment.

**UNIT : II : ORGANIC CHEMISTRY**

**16Hrs.**

**1. Alkaloids :**

03Hrs.

Introduction, classification with examples, general methods of structural elucidation, Hofmann exhaustive methylation with pyridine as example. Synthesis and elucidation of structure of nicotine. Structural formula and uses of Quinine and Atropine.

**2. Terpenes :**

03Hrs.

Occurrence, classification, Isoprene rule, special Isoprene rule, isolation of Terpenes, synthesis and general methods of structural elucidation, structural elucidation of Citral. Structural formula and uses of menthol,  $\alpha$ - pinene and camphor.

**3. Amino Acids, peptides and proteins:**

04Hrs.

Introduction, classification and structure of amino acids, Synthesis of  $\alpha$  – amino acids (from acids, Strecker synthesis and Gabriel- phthalamide synthesis). Acid-Base behavior and isoelectric point of an amino acid.

Peptides- classification, peptide linkage. Synthesis of a dipeptide (Glycylalanine). Proteins – Classification of proteins on composition and molecular shape. Primary and secondary structures of proteins.

**4. Bio-Organic Chemistry :**

06Hrs.

Enzymes: Classification. Characteristic properties of enzymes, mechanism of enzymatic action (Lock and Key theory and template hypothesis) Factors affecting the rate of enzyme catalysis, co- enzymes.

Hormones: Introduction, classification with examples. Hormone secreting glands. Synthesis and importance of Adrenaline and thyroxin. Biological importance of insulin and oxytocin.

Vitamins: Introduction, classification with examples, synthesis of vitamin C.

Biological importance of vitamins A, B1, B2, B6, C, and D



### UNIT : III : PHYSICAL CHEMISTRY

16Hrs.

#### 1. Molecular spectroscopy:

12Hrs.

Electromagnetic radiation, regions of the spectrum. Basic features of different spectrometers, statement of Born-Oppenheimer approximation, degrees of freedom.

Rotational spectrum: Diatomic molecule, energy levels of a rigid rotator (semi-classical principles), spacing of spectral lines, selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length, qualitative description of non-rigid rotator, isotopic effect. Problems.

Vibrational spectrum: Infrared spectrum: -Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant, qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum. Problems.

Raman spectrum: Pure rotational and pure vibrational Raman spectra of diatomic molecules.

#### 2. Radiation Chemistry:

04Hrs.

Introduction, units of radiation, radiolysis of water, dosimeters-Fricke dosimeter and Ceric sulphate dosimeter. Isotopes - Use of radio Isotopes in Tracer technique, Agriculture, Medicine, Food Preservation, and carbon dating.

### CHP : 062 : LABORATORY COURSE-VII

#### Inorganic Chemistry :

48Hrs.

##### Gravimetric estimations:-

1. Estimation of iron as ferric oxide in ferrous ammonium sulphate solution.
2. Estimation of barium as barium sulphate in barium chloride solution
3. Estimation of sulphate as barium sulphate in ammonium sulphate solution.
4. Estimation of nickel as nickel dimethyl glyoximate in nickel sulphate solution.
5. Estimation of Magnesium as oxinate in magnesium sulphate solution.
6. Estimation copper as cuprous thiocyanate in copper sulphate solution.

##### Organic Chemistry :

##### Preparations:

1. Preparation of Acetanilide from aniline
2. Preparation of P-Bromoacetanilide from Acetanilide
3. Preparation of iodoform from acetone.
4. Preparation of Benzoin from benzaldehyde
5. Preparation of m- dinitrobenzene from nitrobenzene
6. Preparation of p- nitro acetanilide from acetanilide
7. Preparation of Benzoic acid from Benzyl chloride
8. Preparation of 2, 4, 6 - tribromoaniline from aniline.

Note: - The gravimetric estimations are to be given in the examinations

**SIXTH SEMESTER**  
**062 CHT : 063 : CHEMISTRY**  
**UNIT : I : INDUSTRIAL CHEMISTRY**

**16Hrs.**

**1. Cement:**

06Hrs.

Introduction, definition, raw materials, grades of cement. Manufacture of Portland cement (by dry and wet process). Mechanism of setting of cement. Types of cement and their uses. R C C

**2. Ceramics, Refractories and glass:**

06Hrs.

Ceramics: Introduction, classification –clay definition, properties and uses.

Refractories : classification – acid, base and neutral refractories

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glass.

**3. Paints, Pigments and Varnishes:**

04Hrs.

Paints : Introduction, requirement of paints, constituents of paints, formulation of paints, failure of paints films (reasons), emulsion paints, manufacture of white lead using Dutch process and uses.

Pigments: Red pigments, white pigments.

Varnishes: Spirit and Oil Varnishes.

**UNIT: II : ORGANIC CHEMISTRY**

**16Hrs.**

**1. Reagents in organic synthesis :**

05Hrs.

Preparations and applications of the following reagents in organic synthesis :  
Lithium aluminium hydride, sodium boro hydride, sodium in liquid ammonia.  
Potassium dichromate, Potassium permanganate, Hydriodic acid.

**2. Green Chemistry:**

03Hrs

Introduction, definition of green chemistry, need of green chemistry in our day today life cycle, basic principle of green chemistry, Green synthesis of adipic acid, urethane and ibuprofen.

**3. Protection and deprotection :**

04Hrs.

Protection and deprotection of the following functional groups

Criteria for the protection and deprotection , amino, hydroxyl, carboxyl and carbonyl groups (at least three reagents for each group).

**4. Medicinal Chemistry :**

04Hrs.

Types of drugs: Definition with Examples (Analgesic, Antipyretic, Anesthetic, Narcotics, Diuretics, Sedatives, Cardiovascular, Antimalarial, Antihepatic, Anticonvulsant, Antiseptic, Antibiotics), Synthesis and uses of Aspirin, Paracetamol, Sulphanilamide, Sulphathiazole and chloramine-T.



**1. Electromotive Force:**

13Hrs.

Electrolytic and Galvanic cells, reversible and irreversible cells. Types of reversible electrodes, metal-metal ion electrode, metal-metal insoluble electrode, amalgam electrode, gas electrode and redox electrode. Electrode reactions in Daniel cell. Sign convention of electrode potential (reduction potential is to be adopted) Emf of the cell and its measurement. Standard electrode potential, Nernst equation for electrode potential and for measuring Emf of the Cell (to be derived) Reference electrodes - calomel electrode, Weston standard cell, polarization, over voltage and Hydrogen over voltage. Problems on the electrode potential and Emf of the cell

Concentration cells - Activity and Activity coefficient of electrolyte

Concentration cells with and without transference, liquid junction potential, salt bridge.

Application of Emf measurements-

Determination of pH of a solution using quinhydrone and glass electrode

Potentiometric titrations - Acid-base and redox titrations.

**2. Electrochemical energy sources.**

03Hrs.

Primary cell (Dry cell) Secondary cell (lead storage cell and Nickel-cadmium cell ), Fuel cells, construction and working of Hydrogen-oxygen fuel cell and its importance.

**CHP: 063: LABORATORY COURSE - VIII**

48Hrs.

**Physical Chemistry :****Instrumental methods of Analysis - II**

1. Determination of degree of dissociation of weak electrolyte.
2. Determination of dissociation constant ( $K_a$ ) of weak electrolyte.
3. Determination of equivalent conductance at infinite dilution of strong electrolyte.
4. Determination of solubility and solubility product of a sparingly soluble salt (say  $\text{BaSO}_4$ ,  $\text{AgCl}$ ,  $\text{AgBr}$ ) by conductance method.
5. Determine the amount of Iron in  $\text{FeCl}_3$  solution and verify the Beer-Lambert's law.
6. Determine the percentage composition of liquid mixture (carbon tetrachloride and benzene) by formula method using Abbe refractometer.
7. Determine the percentage composition of liquid mixture (carbon tetrachloride and benzene) by graphical method using Abbe refractometer.
8. Determine the pH of the following biological juices  
(i) milk (ii) orange juice (iii) lime water (iv) citrus acid solution  
and (v) sodium carbonate
9. Prepare a standard 0.2M  $\text{Na}_2\text{HPO}_4$  and 0.1M citric acid solution, hence prepare Different buffer solutions and determine  $\text{pK}_a$  values of these unknown solutions.
10. Determine the  $\text{pK}_a$  values of given acid by pH metric titration with strong base.
11. Determine the percentage of cane sugar or tartaric acid solution using polarimeter.



### LIST OF REFERENCE BOOKS:

1. College chemistry. B.H Mahajan
2. Text book of Inorganic chemistry. Puri and Sharma.
3. Progressive inorganic chemistry. Suratkar, Thatte and Pandit
4. Selected topics in inorganic chemistry. Satyaprakash, Tuli and Madan
5. Chemistry of rare earth elements Satyaprakash
6. Advanced inorganic chemistry. P.L.Soni
7. A text book of inorganic chemistry. Puri, Sharma and Jauhor
8. Industrial chemistry. B.K.Sharma
9. Industrial chemistry. M.M.Uppal
10. Analytical chemistry. Alka and Gupta.
11. Principles of inorganic chemistry. Puri, Sharma and Kaliya
12. Inorganic chemistry. Chopra and Kapoor
13. Text book of polymers. F.W.Bill, Mayor and J.R.Wiley.
14. Analytical chemistry. B.K.Sharma
15. Vogel's textbook of Quantitative Analysis, sixth edition, J. Mendham, R.C. Denney, J.D.Barnes, MJK Thomas
16. A textbook of macro & semi micro qualitative analysis by A.J. Vogel, fifth edition
17. Inorganic Chemistry, - D.F. Shiver & P.W. Atkins- C.H.Longford ELBS - 2ndedition.
18. Concept and Model of Inorganic Chemistry by Douglas – Mc Daniels - 3rdedition.
19. Chemistry by Raymond Chang - 5thedition
20. New Guide to Modern Valence Theory by G.I. Brown - 3rdedition
21. Co-ordination Compounds by Baselo and Pearson.
22. Inorganic Chemistry by Day and Selbin.
23. Inorganic Chemistry by A. G. Sharpe - 3rd Edition.
24. Coordination Chemistry by A. K. De.
25. Concise Inorganic Chemistry by J.D. Lee - 5thedition.
26. Theoretical Inorganic Chemistry by Day and Selbin
27. Principles of Bioinorganic Chemistry by S. J. Lippard and J. M. Berg, Panima Publishing Corporation, 1stEdn.
28. Inorganic Chemistry by J.E. Huheey, 4thEdn, Pearson Education.
29. Instrumental Methods of Chemical Analysis- Chatwal and Anand
30. Basic Concept of Analytical Chemistry-2nd edition S.M. Khopkar
31. Instrumental Methods of Chemical Analysis- 6th edition, Willard, Merritt, Dean and Settle
32. Analytical Chemistry by Skoog
33. Introduction to Instrumental Analysis- R.D. Braun
34. Inorganic Polymers by G.R.Chatwal Himalaya Publishing House 1st Edn.1996
35. Polymer Science – A Text Book by V.K. Ahluwalia, Anuradha Mishra.
36. Environmental Chemistry – A. K. De, 5th Edition (New age international publishers)
37. Environmental Chemistry – J. W. Moore and E. A. Moore (Academic Press, New York)
38. Environmental Chemistry – A. K. Bhagi and C. R. Chatwal (Himalaya Publishing House)
39. Environmental Chemistry – H. Kaur 2nd Edition 2007, PragatiPrakashan, Meerut, India



40. Environmental Chemistry with Green Chemistry A. K Das , Books and Allied (P) Ltd,
41. Modern Inorganic Chemistry, W. L. Jolly, McGraw Hill Co.
42. University Chemistry, 4th Edition (ISE),B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
43. Essential Trends in Inorganic Chemistry,C. M. P. Mingos, Oxford Univ Press, 1998
44. Chemistry, 3rd Edition,P. Atkins &L.Jones, W. H. Freeman & Company, 1997.
45. Modern Chemistry, 4th Edition,D. W. Oxidby, H. P. Gills & N. H. Nachtrieb, Saunders College Publishing, 1998.
46. Fundamental Concepts of applied Chemistry,Jayashree Ghosh, S Chand Publications.
47. Modern Inorganic Chemistry by C F Bell and K A K Lott
48. University Chemistry by Bruce Mahan
49. Inorganic Chemistry by Chopra and Kapoor
50. Organometallic Chemistry – An introduction by R.C.Mehrotra and A.Singh
51. Inorganic Chemistry by Philips and Williams, Lab Manuals
52. Introduction to inorganic reactions mechanisms by A.C.Lockhart
53. Chemical bonding and molecular geometry by R.J.Gillepsy and P.L.Popelier
54. Advanced Inorganic Chemistry By Gurudeep Raj
55. Analytical chemistry by Gary D Christian, Wiley India
56. Analytical Chemistry by G.L.David Krupadanam, et al, Univ. Press
57. Selected topics in inorganic chemistry by W.D.Malik, G..D.Tuli, R.D.Madan
58. Modern Inorganic Chemistry by William L. Jolly
59. Concise coordination chemistry by Gopalan and Ramalingam
60. Satyaprakash's modern inorganic chemistry by R.D.Madan.
61. Essential trends in Inorganic Chemistry\_ M.P. Mingos, Oxford Univ. Press,1998
62. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
63. Principles and Practicals of Analytical Chemistry, F. W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
64. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
65. Inorganic Chemistry, 3rd edn. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
66. Inorganic Chemistry, 2nd edn. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd.(2005).
67. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).
68. Concepts and Models of Inorganic Chemistry 3rd edn. B.E. Douglas, D.H. McDaniel and Alexander, Wiley (2001).
69. Chemical Applications of Group Theory, 3rd edn, F.A. Cotton, John Wiley and Sons(2006).
70. Molecular Symmetry and Group Theory – Robert L Carter, John Wiley and Sons (2005).
71. Physical Inorganic Chemistry- A Coordination Chemistry Approach- S. F. A. Kettle, Spektrum, Oxford, (1996).
72. Inorganic Chemistry- 2nd edn, C. E. Housecroft and A. G. Sharpe, Pearson Education Ltd,(2005).
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74. Basic Inorganic Chemistry- 3rd edn, F. A. Cotton, G. Wilkinson and P. L. Gaus, John Wiley and Sons, (2002).
75. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
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78. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
79. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.
80. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva books Pvt. Ltd., New Delhi, 2002.
81. The Inorganic Chemistry of Biological Process- 2nd edition , M. N. Hughes, John Wiley and Sons, (1988).
82. Bioinorganic Chemistry- R. W. Hay, Ellis Horwood Ltd, (1984).
83. Biological Inorganic Chemistry –An Introduction, R. R. Crichton, Elsevier, (2008).
84. Bioinorganic Chemistry- A. K. Das, Books and Allied(P) Ltd, (2007).
85. Bioinorganic Chemistry- K. Hussain Reddy, New Age International Ltd. (2003).
86. Bioinorganic Chemistry: A Survey- Eiichiro Ochiai ,Academic Press, (2008).
87. Bioinorganic Chemistry: A Short Course-2nd edition, R. M. Roat-Malone, Wiley Interscience,(2007).
88. Medicinal Applications of Coordination Chemistry- Chris Jones and John Thornback, RSC Publishing, (2007).
89. Transition Metal Complexes as Drugs and Chemotherapeutic Agents-N.Farrell, Kluwer Academic Publishers (1989).
90. The Biological Chemistry of the Elements: The Inorganic Chemistry of Life- 2nd edition, J.J. R. Frausto da Silva and R. J. P. Williams, Oxford University Press,(2001).
91. Text book of organic chemistry. Arun Bhal and B.S.Bhal
92. Advanced organic chemistry . Arun Bhal and B.S.Bhal
93. Reaction mechanism and Reagents in organic chemistry Gurdeep.R.Chatwal
94. Organic chemistry-vol-I, vol-II, vol-III Mukhergi, Singh and Kapoor
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96. Organic chemistry . Morrison and Boyd
97. Organic chemistry L.G.Wade  
Organic chemistry . vol-I,and vol-II I.L.Finar
98. Analytical chemistry . B.K.Sharma
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- 100.Physical chemistry . Negi and Anand
102. Physical chemistry . B.S.Bhal and G.D.Tuli Electrochemistry Glasston Chemical kinetics . Laidler
103. Physical chemistry . Prutto and Maron
104. Physical chemistry . Glasston
105. Physical chemistry R.P.Verma
106. Physical chemistry . Kund and Jain
107. Molecular spectroscopy. S.Banwell
108. Physical chemistry . G.M.Barrow 5<sup>th</sup> Edition
109. Molecular spectroscopy. H.Kour.



**PRACTICAL CHEMISTRY BOOKS :**

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry –F. Daniels et al.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments –J. Rose.
7. Practical Physical Chemistry –S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry –D.V. Jahagirdar, Himalaya Publishing House, Bombay,(1994).
11. Experimental Physical Chemistry –Das. R.C. and Behera B, Tata Mc Graw Hill.
12. Advanced practical physical Chemistry-J.B.Yadav, Krishna Prakashan media(P) Ltd, Meerut.
13. Advanced practical Inorganic Chemistry-Gurudeep Raj, Krishna Prakashan media(P) Ltd, Meerut.
14. Advanced practical organic Chemistry-O.P.Agarwal, Krishna Prakashan media(P) Ltd, Meerut.
15. General Chemistry Experiment – Anil J Elias (University press).
16. Quantitative Chemical Analysis S. Sahay (S. Chand & Co.).
17. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
18. Vogel's textbook of Quantitative Inorganic Analysis-4th edition, Besset Denney, Jaffrey, Mendham
19. Qualitative Inorganic analysis by A.I.Vogel
20. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.
21. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.
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