AC – 20/05/2025
Item No. – 6.19 (N) (3ab) Sem. III & IV

As Per NEP 2020

University of Mumbai

Syllabus for Minor Vertical 2 (Scheme – III)		
Faculty of Science		
Board of Studies in Chemistry		
Second Year Programme in Minor (Chemistry)		
Semester	**III & IV**	
Title of Paper	**Sem.**	**Total Credits 4**
General Principles of Chemistry I	**III**	**2**
Practical in General Principles of Chemistry I		**2**
Title of Paper		**Credits**
General Principles of Chemistry II	**IV**	**2**
Practical in General Principles of Chemistry II		**2**
From the Academic Year		**2025-26**

Sem. - III

Syllabus
B.Sc. (Chemistry)
(Sem.- III)

Title of Paper: General Principles of Chemistry I

Sr. No.	Heading	Particulars
1	**Description the course :**	The course aims to acquaint the students to the fundamental concepts of Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Analytical Chemistry and their applications.
2	**Vertical :**	Minor
3	**Type :**	Theory / Practical
4	**Credit**:	2 credits / 4 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	30 Hours / 60 Hours
6	**Marks Allotted**:	50 Marks/100 Marks
7	**Course Objectives**:	

CO 1	To understand the basic terms of Polymer
CO 2	To Know the different types of polymers and their Properties
CO 3	To calculate Molecular weight of polymer in different method
CO 4	To introduce the Role of Analytical Chemistry, Classification of chemical analysis.
CO 5	To understand the fundamentals of sampling, including its importance, terms Involved, difficulties and types of sampling techniques
CO 6	To Learn Neutralization titrations and indicators to be used based on Ostwald's theory of indicators.
CO 7	To Understand the placement of transition elements in Periodic table and their oxidation state, colour and ability of charge transfer
CO 8	To Learn the basic concept of coordination theory, nomenclature and types of ligands
CO 9	Explore the categorization of acidity and basicity, hydration of cations and Latimer equation
CO 10	Understand the nomenclature, structure, and physical properties of carboxylic acids
CO 11	Analyze the acidic nature of carboxylic acids and the effect of substituents on acidity.

CO 12	Learn common synthetic methods for the preparation of carboxylic acids.
CO 13	Explore the chemical reactivity of carboxylic acids.
CO 14	Understand and apply the mechanism of nucleophilic acyl substitution in the context of acid derivatives

8 Course Outcomes:

	On completing the course, the student will be able to:
OC 1	Know the basic term of polymer '
OC 2	Know the different types of polymer and its properties
OC 3	Calculate molecular weight of polymer.
OC 4	Understand the difference and advantages of Instrumental and Non-instrumental analysis.
OC 5	To adopt proper sampling procedures and equipment for different sample types.
OC 6	Explain endpoint of titration using suitable indicator and proper selection of indicators.
OC 7	Discern the position of transition elements, their oxidation state, colour and ability of charge transfer
OC 8	Determine the rules, theories of coordination compounds and their nomenclature and types of ligands
OC 9	Classify acidity, basicity and deduce equations for hydration of cations and Latimer equation
OC 10	Name carboxylic acids and explain their structure and physical properties
OC 11	Analyze acidity and predict how different substituents influence the acid strength of aliphatic and aromatic acids.
OC 12	Describe and compare various methods for the preparation of carboxylic acids.
OC 13	Explain and predict outcomes of key reactions involving carboxylic acids.
OC 14	Illustrate the mechanism of nucleophilic acyl substitution and apply it to explain reactivity of acid derivatives

9 Modules:-

Semester	Paper	Unit	Description	Credits
III	**Paper I: S3MN31:** General Principles of Chemistry I	**I**	**Physical Chemistry** 1.1 Polymer Chemistry	**02**
		II	**Analytical Chemistry** 2.1 Role of Analytical Chemistry 2.2 Significance of Sampling in Analytical Chemistry 2.3 Neutralization Titration	
		III	**Inorganic Chemistry** 3.1 Covalent bonding 3.2 Selected topics of p block elements	
		IV	**Organic Chemistry** 4.1 Chemistry of Amines and Diazonium Salts	
	Practical: S3MN3P1 Practical in General Principles of Chemistry 1		**Practical Component**	**02**

Unit I	**Physical Chemistry**
1.1	**Polymer Chemistry (8L)** **1.1.1** Basic Terms: Macromolecule, monomer, repeat unit, Polymerisation, (addition and condensation polymerization) Degree of Polymerisation **1.1.2** Classification of Polymer based on source, thermal response. Physical Properties. Polymer structures linear, branched and cross-linked **1.1.3** Molecular weight of Polymers: Definition and formulae of Number average weight average molecular weight Z- average molecular weight, (numerical expected) **1.1.4** Determination of molar mass of polymer using Ostwald viscometer and Mark- Houwink equation
Unit II	**Analytical Chemistry**
2.1	**Role of Analytical Chemistry (2L)** **2.1.1** Language of analytical chemistry: important terms and their significance **2.1.2** Purpose of Chemical Analysis; Analysis Based on (i) the nature of information required:(Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and microanalysis) **2.1.3** Non instrumental and instrumental Methods of Analysis: their types and importance
2.2	**Significance of Sampling in Analytical Chemistry (2L)** **2.2.1** Terms involved in Sampling **2.2.2** Purpose of Sampling **2.2.3** Difficulties encountered in sampling **2.2.4** Types of Sampling (i)Random Sampling (ii)Systematic Sampling **2.2.5** Sampling of gases: ambient and stack sampling.
2.3	**Neutralization Titration (3L)** **2.3.1** Concept of pH and its importance in Neutralization Titrations **2.3.2** Endpoint and Equivalence point of Neutralization titrations **2.3.3** Determination of end point by using Indicators causing colour change **2.3.4** Selection of indicators – Ostwald's theory of indicators
Unit III	**Inorganic Chemistry**
3.1	**Covalent Bonding (3L)** **3.1.1** Interaction between two hydrogen atoms and the potential energy diagram of the resultant system. **3.1.1** Correction applied to the system of two hydrogen atoms formation of H_2
3.2	**Selected topics of p block Elements (5L)** **3.2.1** Preparation, Structure and bonding of tetraborane, Synthesis of Borax and it's uses **3.2.2** Preparation of extrapure silicon
Unit IV	**Organic Chemistry**
	Chemistry of Amines and Diazonium Salts (7L) **4.1.1 Introduction to amines: (1L)** Nomenclature and classification of amines Effect of substituent on basicity of aliphatic and aromatic amines **4.1.2 Method of preparation of amines: (2L)** Reduction of aromatic nitro compounds using catalytic hydrogenation Chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles **4.1.3 Reactions of amines: (2L)** N-alkylation, Hofmann's exhaustive methylation (HEM), N-acylation, Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction. **4.1.4 Diazonium Salts: (2L)** Preparation of diazonium salts Reactions/synthetic application - Sandmeyer reaction, Gattermann reaction,

	Gomberg reaction, Replacement of diazo group by -H, -OH, Azo coupling with phenols, naphthols and aromatic amines.

Practical:
S3MN3P1: Practical in General Principles of Chemistry I

Physical Chemistry

1. To determine the molecular weight of polyvinyl alcohol from viscosity measurement.
2. Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.
3. To determine the solubility product and solubility of AgCl potentiometrically using chemical cell.
4. To determine the amount of Fe (III) present in the given solution by using Salicylic acid by colorimetric titration **(Static Method)** {λ = 525 nm}

Analytical Chemistry

1. **Tools in analytical chemistry I**
   a) Analytical glass wares like burettes, pipettes, Standard flasks, and separating funnels.
   b) Weighing tools such as two pan balance and monopan balance, digital balances:
   c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
   d) Drying Devices: Hot Air Oven, Microwave Oven, Desiccators, Vacuum desiccators
   e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes.
2. Estimation of Mg content in talcum powder by complexometric titration by using a standard solution of EDTA.
3. Conductometry**:** Estimation of acid content by conductometric titration with strong base.
4. Gravimetry - Estimation of sulphate as $BaSO_4$.

Inorganic Chemistry

1. **Inorganic Preparations:**
   i) bis (acetlyacetonato) Cu(II)
   ii) Potassium trioxalato Ferrate $K_3[Fe(C_2O_4)_3].3H_2O$
2. **Complexometric Titration:**
   Estimate the amount of magnesium in the given $Mgso_4$ solution
3. **Gravimetric Estimation:**
   Calculate the percentage composition of the mixture of Na_2CO_3 and $NaHCO_3$

Organic Chemistry

One Step Preparation and Purification: (Any Four preparations)

Use 0.5-1.0g of the organic compound. Purify the product by recrystallization. Report 1) Theoretical yield, 2) Percentage yield and 3) Melting point of the purified product

1. Cyclohexanone oxime from cyclohexanone.
2. Phthalic anhydride from phthalic acid by sublimation
3. Glucosazone from dextrose or fructose
4. Acetanilide from aniline
5. m-Dinitrobenzene from nitrobenzene
6. Tribromoaniline from aniline

❖ **Purification solvent to be given to the students**

11 Reference Books:

Physical Chemistry

1) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
2) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
3) Keith J. Laidler & John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
4) Puri B. R., Sharma L. R. & Pathania M. S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
5) Ball, D. W. Physical Chemistry Thomson Press, India (2007).
6) Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
7) Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
8) McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).

Analytical Chemistry

1) Analytical Chemistry, Gary D. Christan, Purnendu Dasgupta, 7th Edition, Wiley.
2) Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch, 10th edition.
3) Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch, 7th edition.
4) Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, New academic sciences.
5) Modern Analytical Chemistry, David Harvey, 2nd edition, 2009.

Inorganic Chemistry

- **Covalent bonding , Selected Topics of p blocks elements**

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Mileston Publishers, 2013-2014.
2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Pres
3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.
4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, Edition 2005.
5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure a Reactivity, 4th Ed., Harper Collins, 1993.
6. R. L. Dekock and H.B. Gray, Chemical Structure and Bonding, The Benjamin Cummi Publishing Company, 1989.
7. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004.
8. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.
9. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Ltd., 1985.
10. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1
11. D. Banerjea, Coordination Chemistry Tata McGraw Hill,1993.

- **Inorganic Practical**

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. A. I. Vogel, Quantitative Inorganic Analysis, 5th Edn Longman Scientific and Technic 1989.
3. J. D. Woolins, Inorganic Experiments. Hohn Wiley and Sons, 2010
4. G. Raj, Advanced Practical Inorganic Chemistry. Goel Publication, 2010
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, 2013.
6. G. N. Mukherjee, Advanced Experiments in Inorganic Chemistry., U. N. Dhur & Sons Ltd. 2010.
7. G. Christian, Analytical Chemistry, John Wiley, New York 4th edition 1986.

	Organic Chemistry 1. Organic Chemistry by David Klein, 3rd edition, John Wiley and Sons, 2. Organic Chemistry by Wade L.G., JR 8th edition Pearson Education 3. Organic Chemistry by Morrison, R. T. and Boyd, R. N. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012 4. Organic Chemistry (Volume 1), by Finar, I. L. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 5. Fundamentals of Organic Chemistry by Mc Murray, J.E. 7th Ed. Cengage Learning India Edition, 2013. 6. Organic Chemistry by Clayden, J.; Greeves, N., Warren, S., Wothers, P, Oxford University Press. 7. Textbook of Organic Chemistry by Kalsi, P. S. 1st Ed., New Age International (P) Ltd. Pub. 8. Organic Chemistry by Francis Carey, McGraw-Hill Publication. 9. Organic Reaction Mechanisms by Ahluwalia V.K., Parashar R.K., 4th edition, Narosa Publication. 10. A textbook of Organic Chemistry by Bahl A., Bahl B.S., S Chand Publication. 11. Name Reactions by Jie Jack Li, 3rd edition, Springer Publication.	
12	**Internal Continuous Assessment: 40%**	**External, Semester End Examination 60% Individual Passing in Internal and External Examination**
13	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

Sem. - IV

Syllabus
B.Sc. (Chemistry)
(Sem.- IV)

Title of Paper: General Principles of Chemistry II

Sr. No.	Heading	Particulars
1	**Description the course:**	The course is designed to introduce students to the core concepts of Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, and their applications.
2	**Vertical :**	Minor
3	**Type :**	Theory / Practical
4	**Credit**:	2 credits / 4 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	30 Hours / 60 Hours
6	**Marks Allotted**:	50 Marks/100 Marks
7	**Course Objectives**:	

CO 1	To understand the Laws of Crystallography
CO 2	To study the different types crystals
CO 3	To understand the crystal structure and use of X-ray
CO 4	To learn detail concept gravimetric analysis
CO 5	To learn spectroscopic, Thermal methods as Instrumental method of analysis.
CO 6	To understand the application of various tests for the Rejection of doubtful data.
CO 7	To Understand the placement of transition elements in Periodic table and their oxidation state, colour and ability of charge transfer
CO 8	To Learn the basic concept of coordination theory, nomenclature and types of ligands
CO 9	To Explore the categorization of acidity and basicity, hydration of cations and Latimer equation.
CO 10	To Understand the nomenclature, structure, and physical properties of carboxylic acids.
CO 11	To Analyse the acidic nature of carboxylic acids and the effect of substituents on acidity.
CO 12	To Learn common synthetic methods for the preparation of carboxylic acids.
CO 13	To Explore the chemical reactivity of carboxylic acids.
CO 14	To Understand and apply the mechanism of nucleophilic acyl substitution in the context of acid derivatives.

8 **Course Outcomes**:

	On completing the course, the student will be able to:
OC 1	Know the laws of crystallography
OC 2	Different types crystals.
OC 3	To know the use of X-ray in the study of crystal structure.
OC 4	Explain the factors affecting the solubility of a precipitate, different steps involved in precipitation gravimetry, the effect of various experimental factors on the particle size of the precipitate and applications of gravimetric analysis
OC 5	Compare different spectroscopic, electrochemical and Thermal methods.
OC 6	To apply the rejection test for a doubtful value.
OC 7	Discern the position of transition elements, their oxidation state, colour and ability of charge transfer
OC 8	Determine the rules , theories of coordination compounds and their nomenclature and types of ligands
OC 9	Classify acidity, basicity and deduce equations for hydration of cations and Latimer equation
OC 10	Name carboxylic acids and explain their structure and physical properties.
OC 11	Analyze acidity and predict how different substituents influence the acid strength of aliphatic and aromatic acids.
OC 12	Describe and compare various methods for the preparation of carboxylic acids.
OC 13	Explain and predict outcomes of key reactions involving carboxylic acids.
OC 14	Illustrate the mechanism of nucleophilic acyl substitution and apply it to explain the reactivity of acid derivatives.

9	**Modules**

Semester	Paper	Unit	Description	Credits
IV	**Paper I: S3MN41:** General Principles of Chemistry II	**I**	**Physical Chemistry** 1.1 Solid State	**02**
		II	**Analytical Chemistry** 2.1 Classical methods- Gravimetric analysis 2.2 Basic Concepts in Instrumental Methods 2.3 Criteria for rejection of doubtful results and Test of Significance	
		III	**Inorganic Chemistry** 3.1 Comparative chemistry of transition metals 3.2 Coordination chemistry 3.3 Ions in aqueous Medium -I	
		IV	**Organic Chemistry** 4.1 Carboxylic Acids and their Derivatives	
	Practical: S3MN4P1 Practical in		**Practical Component**	**02**

	General Principles of Chemistry II			

Unit I	**Physical Chemistry**
1.1	**Solid State: (7L)** 1.1.1 Laws of Crystallography and Types of Crystals 1.1.2 Characteristics of simple cubic, face-centered cubic and body-centered cubic systems, interplanar distance in a cubic lattice (only expression for ratio of interplanar distances are expected) 1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected)
Unit II	**Analytical Chemistry**
2.1	**Classical methods-Gravimetric analysis** 2.1.1 Introduction and Principle of Gravimetric analysis 2.1.2 Types of Gravimetric Methods (i) Volatilization gravimetry (ii) Precipitation gravimetry 2.1.3 Steps involved in precipitation gravimetric analysis 2.1.4 Applications of Gravimetric Analysis: (i) Determination of sulfur from organic compounds; (ii) Estimation of Nickel in Cu-Ni alloy using dimethyl glyoxime
2.2	**Basic Concepts in Instrumental Methods** 2.2.1 Relation between the Analyte, Stimulus and measurement of change in the observable property. 2.2.2 Types of Analytical Instrumental Methods based on (i) Optical interactions (eg. Spectrometry: UV-Visible, Polarimetry) (ii) Electrochemical interactions (eg. Potentiometry, Conductometry,) (iii) Thermal interactions (eg, Thermogravimetry)
2.3	**Criteria for rejection of doubtful result and Test of Significance** (i) 2.5 d rule and 4.0 d rule (ii) Q test (iii) F-test (variance ratio test)
Unit III	**Inorganic Chemistry**
3.1	**Comparative chemistry of transition metals (4L)** 3.1.1 Position of transition elements in periodic table, occurrence (ores and minerals) 3.1.2 oxidation state and transition elements, Unusual oxidation states, colour, Ability of charge transfer
3.2	**Coordination chemistry (2L)** Introduction to coordination compounds, basic terms and nomenclature, types of ligands.
3.3	**Ions in aqueous medium -I (2L)** Introduction, acidity of cations and basicity of anions, Hydration of cations and Latimer Equation.
Unit IV	**Organic Chemistry**
4.1	**Carboxylic Acids and their Derivatives (7L)** 4.1.1 Recapitulation: (2L) Nomenclature, Structure and physical properties, Acidity of carboxylic acids, Effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 4.1.2 Preparation of carboxylic acids: (1L) Oxidation of alcohols and alkyl benzene, Carbonation of Grignard, Hydrolysis of

	nitriles 4.1.3 Reactions of carboxylic acids: (2L) Salt formation, Decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction (Mechanism not expected) **4.1.4 Nucleophilic Acyl Substitution: (2L)** Mechanism of nucleophilic acyl substitution and acid-catalyzed nucleophilic acyl substitution Application of nucleophilic acyl substitution

Practical:
S3MN4P1: Practical in General Principles of Chemistry II

Physical Chemistry:

1. To understand the effect of concentration on reaction rate by investigating reaction between $K_2S_2O_8$ and KI
2. To verify Ostwald's dilution law for weak acid conductometrically
3. To determine the amount of strong acid present in a given solution by titration with a strong base using a **pH meter**.
4. To determine the standard reduction potential of $Ag|Ag^+$ using *Nernst Equation*

Analytical Chemistry:

1. Tools in Analytical chemistry-II
   a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.
   b. Development chamber for chromatography
   c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)
   d. Conductivity cell (with respect to care and maintenance)
   e. Combined Glass electrode (with respect to care and maintenance)
   f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell
2. Estimation of carbonate and non-carbonate hardness of water.
3. Colorimeter: Estimation of concentration of Iron by using 1,10-phenanthroline.
4. Gravimetry - Estimation of nickel (II) as Ni-DMG.

Inorganic Practical:

1. **Volumetric Analysis / Redox titration**:
   To determine the percentage of calcium carbonate in precipitated chalk
2. To determine volumetrically the strength of given Mohr's salt solution
3. Determine the amount of sodium carbonate and sodium hydroxide present together in the given solution.
4. **Inorganic preparation:** sodium hexanitro cobaltate (III)

Organic Practical:
Characterisation of Organic Compounds (Minimum 4 Compounds to be characterize)
Characterisation of organic compounds on the basis of

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

Suggested Compounds

1) Acid: Salicylic Acid, Phthalic Acid
2) Phenol: Resorcinol
3) Base: o/m/p nitro anilines
4) Neutral: - Benzophenone, Ethyl Benzoate, m – dinitro benzene, Thiourea, Urea

10. **References:**

Physical Chemistry:

1) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
2) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
3) Keith J. Laidler & John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
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8) McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).

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4) Basic Concepts of Analytical Chemistry, S.M. Khopkar, 3rd Edition, New Academic Sciences.
5) Modern Analytical Chemistry, David Harvey,2nd edition, 2009.

Inorganic Chemistry:

- **Chemistry of transition metals, coordination chemistry, ions in aqueous medium**

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers, 2013-2014.
2. W. W. Porterfield, Inorganic Chemistry-A Unified Approach, 2nd Ed., Academic Press, 1993.
3. B. W. Pfennig, Principles of Inorganic Chemistry, Wiley, 2015.
4. C. E. Housecroft and A. G. Sharpe, Inorganic Chemistry, Pearson Education Limited, 2nd Edition 2005.
5. J. Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Ed., Harper Collins, 1993.
6. R. L. Dekock and H.B. Gray, Chemical Structure and Bonding, The Benjamin Cummings Publishing Company, 1989.
7. G. Miessler and D. Tarr, Inorganic Chemistry, 3rd Ed., Pearson Education, 2004.
8. R. Sarkar, General and Inorganic Chemistry, Books & Allied (P) Ltd., 2001.
9. C. M. Day and J. Selbin, Theoretical Inorganic Chemistry, Affiliated East West Press Pvt. Ltd., 1985.
10. G. A. Jeffrey, An Introduction to Hydrogen Bonding, Oxford University Press, Inc., 1997.

11. D. Banerjea ,Coordination Chemistry Tata McGraw Hill,1993.

- **Inorganic Practical**

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
2. A. I. Vogel, Quantitative Inorganic Analysis, 5th Edn, Longman Scientific and Technical, 1989.
3. J. D. Woolins, Inorganic Experiments. Hohn Wiley and Sons, 2010
4. G. Raj, Advanced Practical Inorganic Chemistry. Goel Publication, 2010
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, 2013.
6. G. N. Mukherjee, Advanced Experiments in Inorganic Chemistry., U. N. Dhur & Sons Pvt. Ltd. 2010.
7. G. Christian, Analytical Chemistry, John Wiley, New York, 4th edition, 1986.

Organic Chemistry

1. Organic Chemistry by David Klein, 3rd edition, John Wiley and Sons,
2. Organic Chemistry by Wade L.G., JR 8th edition Pearson Education
3. Organic Chemistry by Morrison, R. T. and Boyd, R. N. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).2012
4. Organic Chemistry (Volume 1), by Finar, I. L. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Fundamentals of Organic Chemistry by Mc Murry, J.E. 7th Ed. Cengage Learning India Edition, 2013.
6. Organic Chemistry by Clayden, J.; Greeves, N., Warren, S., Wothers, P, Oxford University Press.
7. Textbook of Organic Chemistry by Kalsi, P. S. 1st Ed., New Age International (P) Ltd. Pub.
8. Organic Chemistry by Carey Francis, The McGraw Hill Publication.
9. Organic Reaction Mechanisms by Ahluwalia V.K., Parashar R.K., 4th edition, Narosa Publication.
10. A textbook of Organic Chemistry by Bahl A., Bahl B.S., S Chand Publication.
11. Name Reactions by Jie Jack Li, 3rd edition, Springer Publication.

11	**Internal Continuous Assessment: 40%**	**External, Semester End Examination 60% Individual Passing in Internal and External Examination**
12	**Continuous Evaluation through:** Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	

QUESTION PAPER PATTERN
(External and Internal)

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Evaluation Pattern for Semester III and IV:

Theory Paper

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.	As per paper pattern	1 h

Paper Pattern for 30 marks :

30 Marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **one hour** duration.
2. Theory question paper pattern:
   a. There shall be **04** questions.
   b. All questions shall be compulsory with internal choice within the questions.

Question	Option	Marks	Questions Based on
Q.1	A) Objective questions 4 out of 6	04	Uni I
	B) Subjective questions 1 out of 2	04	
Q.2	A) Objective questions 4 out of 6	03	Unit II
	B) Subjective questions 1 out of 2	04	
Q.3	A) Objective questions 4 out of 6	04	Unit III
	B) Subjective questions 1 out of 2	04	
Q.4	A) Objective questions 4 out of 6	03	Unit IV
	B) Subjective questions 2 out of 4	04	
	Total	**30**	

Evaluation Pattern for Practical Course

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Viva/ assignment/ objective question test (15 Marks), Overall performance (5 Marks) = 20 Marks	One experiment (25 marks for experiment and 5 Marks for Journal = 30 Marks)	3 h 30 minutes

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Sd/-
Sign of
Dr. Sunil Patil
Coordinator,
Board of Studies in Chemistry

Sd/-
Sign of
Prin. (Dr.) Madhav Rajwade
Offg. Associate Dean,
Faculty of Science and Technology

Sd/-
Sign of
Prof. (Dr.) Shivram Garje
Offg. Dean,
Faculty of Science and Technology