SOMAIYA
VIDYAVIHAR
K J Somaiya College of Science & Commerce
Autonomous (Affiliated to University of Mumbai)

Somaiya
TRUST

S. Y. B.Sc. Chemistry

Syllabus

from

Academic year 2022- 23

Course No.	Course Title	Course code	Credits	Hour	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
SEMESTER III										
Core courses THEORY										
I	Physical Chemistry I	22US3CHCC1PHC1	2	30	36	3	12	40	60	100
II	Inorganic Chemistry I	22US3CHCC2INC1	2	30	36	3	12	40	60	100
III	Organic Chemistry I	22US3CHCC3ORC	2	30	36	3	12	40	60	100

		1								
Core courses PRACTICAL										
P	Based on CC I, II and III	22US3CHCCP	3					60	90	150
SEMESTER IV										
Core courses THEORY										
I	Physical Chemistry II	22US4CHCC1PHC2	2	30	36	3	12	40	60	100
II	Inorganic Chemistry II	22US4CHCC2INC2	2	30	36	3	12	40	60	100
III	Organic Chemistry II	22US4CHCC3ORC2	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
P	Based on CC I, II and III	22US4CHCCP	3					60	90	150

S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- I

COURSE TITLE: Physical Chemistry

COURSE CODE: 22US3CHCC1PHC1 [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Describe the basic concepts of Photochemistry and UV Visible spectroscopy.
2. Recognize the different conductive properties of electrolytes.
3. Illustrate the classical and instrumental methods of analysis.

Module 1	Photochemistry and UV Visible spectroscopy	[12L]

Learning Objective:

The module is intended to explore the concepts of Photochemistry and UV-Visible spectroscopy.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Explain photophysical phenomena using Perrin- Jablonski Diagram

2. Solve numerical problems based on Quantum yield of various photochemical reactions

3. Illustrate environmental phenomena like photochemical smog formation, air pollution, ozone depletion using photochemical reactions and photophysical processes

4. Employ principles of photochemistry for development of renewable energy sources like

solar energy 5. Apply Beer Lambert's Equation for quantitative analysis using UV -Visible spectrophotometric methods		
1.1	**Photochemistry**	**8L**
1.1.1	Photochemistry: Consequences of light absorption- The Jablonski diagram, radiative and non -radiative transitions, fluorescence and phosphorescence, Singlet and triplet states	
1.1.2	Laws of photochemistry- Grotthus Drapers law and Stark Einstein Law, Definition of energy of a photon and einstein in different unit, quantum efficiency, reasons for low and high quantum yield, experimental determination of quantum yield, Mechanism of photochemical reactions: Primary and secondary processes with suitable examples: 1) Reaction between hydrogen and chlorine, 2) Dissociation of hydrogen iodide	
1.1.3	Energy transfer in photochemical reactions: Photosensitization, Bioluminescence, Chemiluminescence, photochemical smog, ozone depletion	
1.1.4	Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters, silicon solar cell.	
1.2	**UV Visible Spectroscopy**	**4L**
1.2.1	U.V. and visible spectroscopy, absorption spectroscopy, terms involved: radiant power, absorbance, transmittance, percentage transmittance, wavelength of maximum absorption	
1.2.2	Statement of the Beer’s law and the Lambert’s law (derivation expected), Combined expression, molar	

	extinction coefficient, deviations from Beer – Lambert law, limitations of the law.	
1.2.3	Components of an optical instrument, photometers and spectrophotometers, construction of a single beam photometer & double beam photometer.	
1.2.4	Photometric Titrations: Basic principles, titration curves, advantages and limitations.	

References:

- Photochemistry - Principles of Physical Chemistry, Puri, sharma, Pathania, Vishal Publishing House, pg 1112-1146,46th Ed.
- UV Visible Spectroscopy-Fundamentals of Analytical Chemistry by Skoog and West ,9th Ed., pg 722-744

Module 2	**Solutions of Electrolytes**	**[12L]**

Learning Objective:

This module is intended to discuss different conductive properties of electrolytes.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Define and correlate different terms such as conductance, specific conductance, equivalent conductance and molar conductance of electrolytes.
2. Explain Debye-Huckel theory of conductance of strong electrolytes.
3. Describe Kohlrausch's law of independent migration of ions and its applications.
4. Illustrate the dependence of transport number on velocity of ions.
5. Discuss the method to find the transport number of ions.

2.1	Electronic and electrolytic conductors, conductance, specific conductance, equivalent conductance, molar conductance, variation of molar conductance with concentration for strong and weak electrolytes. Concept of limiting molar conductance.	3L
2.2	Debye-Huckel theory of conductance of strong electrolytes.	2L

	Ionic atmosphere, relaxation effect, electrophoretic effect.	
2,3	Kohlrausch's law of independent migration of ions, applications of the law – determination of limiting molar conductance of weak electrolytes, determination of dissociation constant of a weak acid, determination of solubility product of a sparingly soluble salt.	3L
2.4	Migration of ions, transport number, dependence of transport number on velocity of ions	2L
2.5	Relationship between transport number, ionic mobility and equivalent conductance.	2L

References:

- Electrolyte Solution, R. A. Robinson and R.H. Stokes, Second Revised Edition, Butterworth & Co (Publishers) Ltd.

Module 3	**Titrimetric Analysis and Use of Instrumental Methods in Titrimetric Analysis**	**[12L]**

Learning Objectives:

The module is intended to discuss the titrimetric and instrumental methods of quantitative analysis.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Describe the concepts of Acid-Base titration and the pH changes in the vicinity of equivalence points
2. Selection of indicators for different types of neutralisation reactions.
3. Understand and predict the emf changes while carrying out Redox titration.
4. Interpret the equivalence point using instrumental methods of analysis.
5. Illustrate the advantages of instrumental methods of analysis over classical methods of analysis.

3.1	**Titrimetric Methods of Analysis**	**7L**
3.1.1	Theory of acid – base titrations: construction of titration curves and choice of indicators in the titration of (a) strong acid and strong base, (b) strong acid and weak base, (c)	

	weak acid and weak base, (d) dibasic acid and strong base.	
3.1.2	Redox titrations: General introduction, theory of redox indicators, criterion for a redox titration, construction of titration curves in the case of (a) Fe (II) vs Ce (IV), (b) Fe (II) vs dichromate, use of diphenyl amine and ferroin as redox indicators.	
3.2	**Instrumental methods in Titrimetric analysis**	**5L**
3.2.1	Conductometric Titrations: Basic principles, experimental setup, titration curves in the titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base, (iii) weak acid vs. weak base, (iv) mixture of strong acid and weak acid/ strong base and weak base vs. strong base / weak base or strong acid/ weak acid. (v) sodium chloride vs. silver nitrate (vi) Barium hydroxide vs. magnesium sulphate, advantages and limitations of conductometric titrations.	
3.2.2	Potentiometric titrations: Basic principles, concept of indicator electrode, indicator electrodes for different types of titrations, determination of end points from the graphs of E vs. V, ΔE/ΔV vs. mean volume, Δ2E/ΔV2 vs. mean volume, advantages and limitations of potentiometric titrations.	

References:

- Vogel's Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J. B. Barnes, M. Thomas, B. Sivsankar, 2009, Pearson Publication

Question Paper Template

S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- I

COURSE TITLE: Physical Chemistry I

COURSE CODE: 22US3CHCC1PHC1 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	06	10	07	04	03	-	30
II	08	10	08	04	-	-	30
III	05	10	08	04	03	-	30
Total marks per objective	19	30	23	12	06		90
% Weightage	21	33	26	13	7	0	100

S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- II

COURSE TITLE: Inorganic Chemistry

COURSE CODE: 22US3CHCC2INC1 [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Illustrate the inter relationship between electronic configuration and properties of main group elements and discuss the different compounds of main group elements with respect to preparation, properties and structure.
2. Explain the properties of transition elements and the chemistry of coordination compounds.
3. Correlate the link between theoretical principles of quantitative analysis and practical techniques.

Module 1	Comparative Chemistry of Main group elements	[12L]

Learning Objectives:

The module is intended to

1. Relate electronic configuration and properties of elements by a comparative method.
2. Interpret the properties of main group elements based on their electronic configuration.
3. Discuss the different compounds of main group elements which are important from the point of view of theoretical chemistry like type of bonding and also their

<table>
<tr><td colspan="3">applications.</td></tr>
<tr><td colspan="3">**Learning Outcomes:**
After the successful completion of the module, the learner will be able to
1. Explain the interrelationship between electronic configuration and properties of elements
2. Predict the properties of elements based on the position of elements in the periodic table
3. Describe different types of bonds, structures and properties of compounds of main group elements.</td></tr>
<tr><td>**1.1.**</td><td>**Comparative Chemistry of Main group elements**</td><td>**3L**</td></tr>
<tr><td>1.1.1</td><td>Introduction, trends in properties like atomic and ionic radii, ionization energy, electronegativity, metallic and non-metallic character. Oxidation states, inert pair effect, covalency, catenation, allotropy.</td><td></td></tr>
<tr><td>1.1.2</td><td>Anomalous behavior of second period elements and diagonal relationship.</td><td></td></tr>
<tr><td>**1.2**</td><td>**Chemistry of Boron compounds**</td><td>**3L**</td></tr>
<tr><td>1.2.1</td><td>Boron hydrides-preparation and properties.</td><td></td></tr>
<tr><td>1.2.2</td><td>Electron deficient compounds.</td><td></td></tr>
<tr><td>1.2.3</td><td>Structure and bonding in diborane.</td><td></td></tr>
<tr><td>**1.3**</td><td>**Chemistry of Silicon and Germanium**</td><td>**3L**</td></tr>
<tr><td>1.3.1</td><td>Compounds of silicon-silicates, zeolites, glass, silicones (types, methods of preparation and uses of different silicones).</td><td></td></tr>
<tr><td>1.3.2</td><td>Preparation of extra pure Silicon/Germanium, n-type and p-type of semiconductors</td><td></td></tr>
<tr><td>**1.4**</td><td>**Chemistry of Nitrogen and Oxygen family**</td><td>**3L**</td></tr>
<tr><td>1.4.1</td><td>Oxides and oxyacids of nitrogen and sulphur.</td><td></td></tr>
<tr><td>1.4.2</td><td>Hydrides of Group 15 and 16 elements. Trends in physical properties of hydrides based on hydrogen bonding.</td><td></td></tr>
</table>

References:

- Gurudeep Raj, Advanced Inorganic Chemistry, Vol. 1.
- Gurudeep Raj, Advanced Inorganic Chemistry, Vol. 2.

Module 2	**Comparative Chemistry of Transition Elements**	**[12L]**

Learning Objectives:

This module is intended to

1. Explain the position of transition elements in the periodic table and their electronic configuration.
2. Summarize various properties of transition elements.
3. Describe the basic concepts involved in coordination chemistry.
4. Understand the basic theories of bonding in coordination compounds.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Describe various properties such as colour, magnetic behaviour and applications of transition elements such as catalyst, alloys.
2. Illustrate applications of coordination compounds in various fields such as Photography, qualitative estimation, volumetric estimation, metallurgy, colorimetric and spectrophotometry.
3. Predict the isomerism in coordination compounds.

2.1	**Comparative Chemistry of Transition Elements**	**6L**
2.1.1	Introduction, definition, position in the periodic table, electronic configuration and classification.	
2.1.2	Physical properties with respect to atomic and ionic radii, metallic character, electrical and thermal conductivities, atomic volume and density, M.P. and B.P.	
2.1.3	Ionization potential and relation between ionization potential and stability of metal in a given oxidation state, Standard reduction potential values.	
2.1.4	Variable oxidation state, stabilization of low and high oxidation state.	
2.1.5	Acidic and basic character of the compounds of given	

	transition metal in various oxidation states.	
2.1.6	Colour and magnetic properties, Determination of para and diamagnetic nature of a given substance.	
2.1.7	Tendency of transition metals to form complex compounds, Formation of interstitial compounds, Catalytic activity and applications.	
2.2	**Chemistry of coordination compounds**	**6L**
2.2.1	Basic concepts: Distinction between double salts and coordination compounds. Terms involved in coordination chemistry, complex ion, ligands. Ambidentate ligands: NO_2^- SCN^-, CN^- $S_2O_3^{2-}$ Bridging ligands: OH^-, NH_2^-, NH_2^-, O_2^{2-}, NO_2^- Flexidentate ligands: SO_4^{2-}, CO_3^{2-} Chelating ligands	
2.2.2	Werner's theory of coordination compounds and EAN. (Problem based)	
2.2.3	Isomerism: Conformation: Ionisation, Hydrate, coordination, linkage, coordination position, ligand, polymerization. Stereoisomerism: Geometrical isomerism in square planar and octahedral geometry Optical isomerism	
2.2.4	Applications of coordination compounds, Complex formation in various fields: Photography, qualitative estimation, volumetric estimation, metallurgy, colorimetric and spectrophotometry	

References:

- Satyaprakash, G. D. Tuli, S. K. Basu, Advanced Inorganic Chemistry, Vol. 1.
- Satyaprakash, G. D. Tuli, S. K. Basu, Advanced Inorganic Chemistry, Vol. 2.

Module 3	**Gravimetric and volumetric analysis**	**[12L]**

Learning Objectives:

The module is intended to

1. Discuss theoretical and practical aspects of Gravimetric analysis.
2. Explain theoretical aspects of precipitation titrations.
3. Summarize different aspects of complexometric titrations.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Identify the various steps involved in gravimetric analysis and the use of organic reagents in gravimetric analysis.
2. Summarize different methods used in precipitation titrations and the use of adsorption indicators.
3. Explain different types of EDTA titrations, theory of metallochromic indicators.

3.1	**Gravimetric analysis**	**5L**
3.1.1	Definition and types of gravimetric analysis.	
3.1.2	Solubility considerations: common ion effect, diverse ion effect, pH, temperature and nature of solubility, controlling particle size and treatment of gravimetric precipitates.	
3.1.3	Different steps involved in gravimetry: Digestion, Filtration and washing, Drying and ignition	
3.1.4	Use of organic reagents in gravimetric analysis (Numerical problems on this topic expected)	
3.2	**Precipitation titrations**	**3L**
3.2.1	Introduction and theoretical aspects of precipitation	
3.2.2	Argentimetric titration, construction of titration curves.	
3.2.3	Mohr’s method, Volhard’s method for determination of halides	
3.2.4	Use of Adsorption indicators	
3.3	**Complexometric titrations**	**4L**
3.3.1	General introduction, use of EDTA as a titrant, absolute and conditional stability constant of metal-EDTA complexes.	
3.3.2	Types of EDTA titrations, methods for increasing selectivity of EDTA titrations.	

3.3.3	Theory of metallochromic indicators, examples and use.	
3.3.4	Applications of EDTA titrations.	

References:

- Evelyn M. Rattenbury, Introductory and titrametric and gravimetric analysis, 1st edition.
- G. Christian, P. H. Dasgupta and H. A. Schug, Analytical chemistry, 7th Edition, Wilay.

Question Paper Template

S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- II

COURSE TITLE: Inorganic Chemistry I

COURSE CODE: 22US3CHCC2INC1 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	14	6	-	-	-	30
II	9	14	7	-	-	-	30
III	12	10	5	3	-	-	30
Total marks per objective	31	38	18	3	-	-	90
% Weightag	34	42	21	3	-	-	100

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S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- III

COURSE TITLE: Organic Chemistry

COURSE CODE: 22US3CHCC3ORC1 [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Explain the formation of organic reactive intermediates and justify their stability and reactivity.
2. Discuss the fundamentals of stereochemistry, the interconversion of different projection formulae and configurational descriptors using CIP rule.
3. Describe the basic terminology of chemical plant and explain the synthesis of certain commercially important molecules.
4. Compare the renewable and non-renewable sources of organic compounds.

Module 1	Fundamentals of organic reaction mechanism	[12L]

Learning Objectives:

The module is intended to

1. Discuss the structure, stability and reactions of carbocations, carbanions, carbon free radicals and carbenes.
2. Explain the applications of the above organic intermediates.
3. Illustrate the concept of tautomerism in organic compounds.
4. Distinguish between aromatic, non-aromatic and antiaromatic compounds

by their structures

5. Describe the mechanism of aromatic electrophilic substitution reactions.
6. Explain the orientation and reactivity of substituted benzene towards electrophilic aromatic substitution

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Relate the structure, stability and reactions of carbocations, carbanions, carbon free radicals and carbenes.
2. Explain the stability of organic compounds based on the concept of tautomerism.
3. Classify aromatic, non-aromatic and antiaromatic compounds according to the classical rules.
4. Write the mechanism of aromatic electrophilic substitution reactions.
5. Predict the orientation and reactivity of substituted benzene towards electrophilic aromatic substitution.

1.1	**The mechanism of reactions involving the following reactive intermediates:**	**6L**
1.1.1	**Carbocations**: Structure and stability, Different types of carbocations such as alkyl, allyl, benzyl. Mechanisms involving carbocation - SN1 reaction, Electrophilic addition across an olefinic double bond, E1 mechanism, Rearrangement- Wagner Meerwein rearrangement.	
1.1.2	**Carbanions:** Structure and stability, Concept of carbon acid. Alkylation of carbon acids (active methylene compounds and terminal alkynes) using alkyl halides and synthetic applications of these reactions.	
1.1.3	**Carbon radicals:** Structure and stability, General reactions of radicals – abstraction, addition to C=C, combination, disproportionation. Polymerization	
1.1.4	**Carbenes:** Structure and stability, Generation of carbenes	

	through alpha elimination, from diazoalkanes, from ketenes. Reactions: insertion into C-H bond and addition to olefins.	
1.2	**Tautomerism** Keto-enol tautomerism in aldehydes and ketones, acid and base catalysed enolisation, enol content and stabilized enols : β – ketoesters, β-diketones, phenols.	1L
1.3	**Aromatic Electrophilic Substitution Reaction**	5L
1.3.1	Electronic structure and Huckel's Rule of aromaticity and its applications to carbocyclic and heterocyclic, benzenoid and non-benzenoid compounds and ions. Concept of antiaromaticity	
1.3.2	General mechanism of aromatic electrophilic substitution reaction with energy profile diagram	
1.3.3	Drawing resonance structures of monosubstituted benzenes - Activated and deactivated aromatic rings.	
1.3.4	Effect of electron withdrawing and electron donating substituents on the orientation of an incoming electrophile on the basis of – (i) electron density distribution (ii) stability of intermediate. Cases to be studied: Mono and disubstituted benzenes containing groups - alkyl, amino, hydroxyl, alkoxy, halo, acyl, nitro, carboxy. ortho - para ratio.	

References:

- Morrison R.T. and Boyd, R.N. Organic chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2012.
- Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- B. Y. Paula Organic Chemistry 8th edition, Pearson, 2020.

Module 2	**Stereochemistry-I**	**[12L]**

Learning Objectives:

This module is intended to:

1. Explain the concept of isomerism.
2. Describe the representation of organic compounds using Fischer, Newman and Sawhorse projection formula.
3. Illustrate the conformational analysis of alkanes.
4. Discuss the identification of the stereocenters in a molecule and assignment of configuration.
5. Explain the various resolution techniques.

Learning Outcome:

After the successful completion of the module, the learner will be able to

1. Differentiate structural isomers and stereoisomers.
2. Draw structures of organic compounds using Fischer, Newman and Sawhorse projection formulae.
3. Discuss the stability in various conformations of simple alkanes
4. Identify the stereocenters in a molecule and assign the configuration.
5. Illustrate suitable methods of resolution of racemic mixture.

2.1	**Isomerism:** Types of isomerism, structural isomerism (chain, position & functional) and stereoisomerism (Geometrical & optical).	**4L**
2.2	**Chirality:** Asymmetric carbon atom, enantiomers, stereogenic centre, configuration, Representation of configuration by flying wedge formula & projection formula- Fischer, Newmann, sawhorse.	
2.3	**Assigning stereo descriptors to chiral centres** Cahn-Ingold-Prelog (CIP) Rules of assigning absolute configuration (R and S) to stereogenic centres, Assigning absolute configuration to molecules having maximum two chiral carbon atoms.	**4L**
2.4	Stereochemistry of carbon compounds with one and two	

<table>
<tr><td></td><td>similar and dissimilar asymmetric carbon atoms; enantiomers, diastereomers and racemic mixture and their properties, threo, erythro and meso isomers.</td><td></td></tr>
<tr><td>2.5</td><td>Diastereomers (geometrical isomerism) due to restricted rotation around carbon-carbon double bonds. E and Z stereo descriptors to geometrical isomers.
Diastereomers of disubstituted cycloalkanes (3 and 4 membered rings).</td><td>2L</td></tr>
<tr><td>2.6</td><td>Resolution of enantiomers: chemical and chromatographic method</td><td>2L</td></tr>
<tr><td colspan="3">References:
• Eliel E.L. and Wilen, S.H. Stereochemistry of organic compounds, John Wiley & Sons, 2008.
• Kalsi, P.S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
• Stereochemistry of Organic compounds: Principles and Applications, D.Nasipuri, 4th Edition, New Age International Publishers, 2012.</td></tr>
<tr><td>Module 3</td><td>Chemical industry</td><td>[12L]</td></tr>
<tr><td colspan="3">Learning Objectives:
The module is intended to
1. Discuss the basic terminology used in the chemical industry.
2. Illustrate the importance and use of organic chemistry in synthesis of drugs, dyes, artificial sweeteners and natural products.</td></tr>
<tr><td colspan="3">Learning Outcomes:
After the successful completion of the module, the learner will be able to
1. Discuss the basic idea of the chemical plant.
2. Illustrate the flow diagrams in manufacture of chemicals.
3. Apply basic principles of organic chemistry in synthesis of drugs, dyes and perfumes.</td></tr>
<tr><td>3.1</td><td>Chemical Industry
Introduction to aspects of a chemical plant, terminology</td><td>4L</td></tr>
</table>

	[raw materials, intermediates, end products, by-products, waste], unit operations, unit processes [single and multiple], batch and continuous operations, block diagrams, flow diagrams	
3.2	**Manufacture of bulk chemicals** Phenol and dodecyl benzene sulphonate [including reactions and reaction conditions, block / flow diagram, description]	**3L**
3.3	**Synthesis of Molecules of Commercial importance**	**5L**
3.3.1	Artificial sweeteners-Aspartame, Saccharin, Sucralose	
3.3.2	Dyes- Para Red, Alizarin, Metanil Yellow	
3.3.3	Dye intermediate: β-Nitro styrene	
3.3.4	Drugs- Pethidine (Demerol), Lidocaine	
3.3.5	Perfumes: Civetone, Coumarin	
3.3.6	Nutraceutical: β-Alanine	
3.3.7	Natural Product: Piperine, Geranic acid	
3.3.8	Flavour: Fumaric acid	

References:

- Unit operations and processes – P. H. Groggins.
- Industrial Organic Chemistry, Klaus Weissermel and Hans-Jürgen Arpe,3rd, Completely Revised Edition, 2008.
- Industrial Chemistry-B.K.Sharma, Goyal publishing house.
- Name reactions: A Collection of Detailed Mechanisms and Synthetic Applications, Fifth Edition, Jie Jack Li, Springer, 2014.

Module 4	**Renewable and Non-renewable sources of organic compounds (optional)**	**[12L]**

Learning Objective:

The module is intended to discuss the renewable and non-renewable sources of aromatic and aliphatic organic compounds.

Learning Outcome:

After the successful completion of the module, the learner will be able to discuss the importance of using the fast-replenishing sources carefully and focus on alternative organic resources.

4.1	Sources of Organic compounds	
4.2	Coal	
4.3	Petroleum	
4.4	Natural gas	
4.5	Synthesis gas	
4.6	Oligomerization and metathesis of olefins	
4.7	Future of Natural gas and Coal	
4.8	Nuclear Fuel	
4.9	Biomass	
4.10	Biofuels	

References:

- Coal and combustion: Dr. Kale
- Renewable sources of energy and environment: E. Hinnawi and A.K.Biswas, Tycooly International Publishing, Dublin, Eire, 1981, 234 pp.

Question Paper Template

S.Y. B. Sc. (CHEMISTRY) SEMESTER III

Core Course- III

COURSE TITLE: Organic Chemistry I

COURSE CODE: 22US3CHCC3ORC1 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	8	9	7	6	-	-	30
II	8	7	9	6	-	-	30
III	15	15	-	-	-	-	30
Total marks per objective	31	31	16	12	-	-	90
% Weightage	35	35	17	13	-	-	100

S. Y. B. Sc. (CHEMISTRY)

SEMESTER III - Practical

COURSE CODE: 22US3CHCCP **Credit- 03**

Learning Objectives:

The Practical is intended to

1. Investigate the amounts of solutes using instrumental methods of analysis.
2. Discuss the Semi Micro Qualitative Analysis for an inorganic mixture
3. Synthesize and purify various organic compounds
4. Discuss the mole concept for percentage yield calculation of organic reaction.

Learning Outcome:

After the successful completion of the practical, the learner will be able to

1. Estimate the amount of solute present in a given solution using instrumental methods.
2. Use the Semi Micro Qualitative Analysis for an inorganic mixture
3. Perform organic synthesis involving nitration, oxidation, hydrolysis etc.
4. Practice the techniques involving drying and purification by various method.
5. Estimate percentage yield of organic reaction

Core Course I	**Physical Chemistry I**

1. To determine the amount of strong acid present in the given solution by titration with strong base conductometrically.
2. To determine the amount of strong and weak acid present in the given solution by titration with strong base conductometrically.
3. To verify Ostwald’s dilution law using a weak acid
4. To determine dissociation constant of a weak acid using Henderson’s equation
5. To verify Beer-Lambert law, using potassium permanganate solution.

Core Course II	**Inorganic Chemistry II**

1. **Semi Micro Qualitative Analysis**
2. **Inorganic Preparations**
    i. Pottassium trioxalatoferrate (III)
    ii. Ferric ammonium sulphate (Ferric alum)

Core Course III	Organic Chemistry III

Organic derivative Preparation

1. Preparation of picrate derivative of aromatic compound.
2. Oxidation of aldehyde to carboxylic acid
3. N-Acetylation of aromatic primary amine
4. O-Acetylation of phenol
5. Hydrolysis of ester/amide
6. 2,4-Dinitrophenyl hydrazine derivative of ketone
7. Nitration of Nitrobenzene
8. Osazone formation of carbohydrates

References:

- Experimental Physical Chemistry, V. D. Athawale, 2007 New Age International Publishers.
- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- I

COURSE TITLE: Physical Chemistry

COURSE CODE: 22US4CHCC1PHC2 [CREDITS - 02]

Course Learning Outcome

After the successful completion of the Course, the learner will be able to:

1. Explain the kinetics of different types of reactions and identify the different types of electrochemical cells based on their properties.
2. Discuss the behaviour of ideal solutions, separation methods and techniques of solvent extraction.
3. Apply Laws of Crystallography and XRD technique to explain crystal structure
4. Classify and determine the average molecular weight of polymer using different methods.

Module 1	Chemical Kinetics and Electrochemical cells	[12L]

Learning Objective:

The module is intended to discuss the basic concepts of Chemical kinetics and to give ideas about different electrochemical cells

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Classify different types of reactions based on order and Molecularity.

2. Discuss different methods to determine the order of a reaction.
3. Classify different types of electrodes.
4. Compare different electrochemical reactions and write the cell reactions.
5. Discuss the thermodynamic parameters for the cell reaction.
6. Examine Nernst's equation for cell EMF.

1.1	**Chemical Kinetics**	**4L**
1.1.1	Definition of terms – order, rate and molecularity	
1.1.2	Experimental methods to study the kinetics of reactions, rate law, rate constant, units of rate constant.	
1.1.3	Integrated rate equation for zero, first and second order reactions, pseudounimolecular reactions.	
1.1.4	Methods of determination of order of reactions.	
1.2	**Electrochemical Cells**	**8L**
1.2.1	Galvanic and electrolytic cells, types of electrodes – ion-specific and ion-selective, comparison, types of ion-specific electrodes – (1) metal-metal ion electrodes, (2) gas electrodes (3) metal – metal insoluble salt type electrodes, (4) redox electrodes	
1.2.2	Cell representation and cell reaction (students are expected to write the cell reaction for a given cell and vice versa.	
1.2.3	Reversible & irreversible cells, chemical & concentration cells, primary & secondary cells.	
1.2.4	Thermodynamic parameters - ΔG, ΔH and ΔS for the cell reaction taking place in a cell.	
1.2.5	Nernst's equation for cell EMF and hence for a single electrode potential. (Derivation and numerical problems expected).	
1.2.6	Determination of equilibrium constant from EMF measurements.	

References:

- Principles of Physical Chemistry, Puri, Sharma, Pathania, 41st Millennium Edition,

Vishal Publishers		
Module 2	**Solutions of Non-electrolytes and Nernst Distribution Law**	**[12L]**
Learning Objectives: This module is intended to discuss the behavior and applications of non- electrolytes		
Learning Outcome: After the successful completion of the module, the learner will be able to 1. Discuss the behavior of ideal solutions. 2. Distinguish between an ideal and non-ideal solution 3. Apply and select the techniques for the separation and purification of liquid-liquid mixture. 4. Illustrate the Nernst's distribution law and it's deviations. 5. Solve the numericals to find equilibrium constant values.		
2.1	**Solutions of Non-electrolytes**	**7L**
2.1.1	Solution of gases in liquids, Henry's law	
2.1.2	Solutions of liquids in liquids – Completely miscible liquids, Raoult's law, ideal solutions, phase diagrams – pressure vs. composition and temperature vs. composition. Distillation of mixtures forming ideal solutions, fractional distillation, distillation under reduced pressure, deviation from Raoult's law – positive and negative deviation, non-ideal solutions, azeotropes, distillation of azeotropic mixtures, breaking of azeotropic mixtures.	
2.1.3	Partially miscible liquids – (i) with upper critical solution temperature (UCST) (ii) with lower critical solution temperature (LCST), (iii) with UCST & LCST.	
2.1.4	Completely immiscible liquids, steam distillation	
2.2	**Nernst Distribution Law**	**5L**
2.2.1	The Nernst distribution law, partition coefficient and distribution ratio, solutes undergoing association and dissociation	
2.2.2	Applications of the law – study of complex ions and solvent	

	extraction.	
References: • Principles of Physical Chemistry, Puri, Sharma, Pathania, 41st Millennium Edition, Vishal Publishers		
Module 3	**Crystalline State and Introduction to physical chemistry of Polymers**	**[12L]**
Learning Objective: The module is intended to discuss crystalline states and physical chemistry of polymers.		
Learning Outcomes: After the successful completion of the module, the learner will be able to 1. Identify different crystal planes and cubic systems 2. Evaluate interplanar distances in cubic lattices 3. Interpret X ray diffraction data for determination of crystal Structure 4. Determine the molecular weight of polymers using different methods		
3.1	**Crystalline State**	**8L**
3.1.1	Characteristics of simple cubic, face-centered and body-centered cubic systems, Interplanar distance in cubic lattices.	
3.1.2	Use of X-rays in the study of crystal structure, Bragg's equation, (derivation expected), X-ray diffraction method of studying crystal lattices,	
3.1.3	structure of NaCl and KCl. Determination of Avogadro's number, Crystal defects – Schottky and Frenkel defects.	
3.2	**Introduction to physical chemistry of Polymers**	**4L**
3.2.1	Basic terms and their definitions	
3.2.2	Classification based on (1) source, (2) structure, (3) thermal response, (4) physical properties, (5) method of preparation	
3.2.3	Molar mass of polymers – number average, weight average, viscosity average and Z-average. Monodispersity and polydispersity.	
3.2.4	Methods of determination of molar masses of polymers –	

	(1) ultracentrifuge (limiting or sedimentation velocity method only), (2) Viscosity method (Mark – Houwink equation).	
3.2.5	Introduction to light emitting polymers, applications of LEP.	

References:

- Solid State Chemistry and Its Applications, Anthony R West, 2012, Willey Edition
- Text Book of Polymer Chemistry, Dr. M.S Bhatnagar, 2004, S. Chand Publications.

Question Paper Template

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- I

COURSE TITLE: Physical Chemistry II

COURSE CODE: 22US4CHCC1PHC2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	**08**	**08**	**08**	**04**	**02**	**-**	**30**
II	**08**	**09**	**08**	**05**	**-**	**-**	**30**
III	**08**	**07**	**10**	**05**	**-**	**-**	**30**
Total marks per objective	**24**	**24**	**26**	**14**	**02**	**-**	**90**
% Weightage	**27**	**27**	**28**	**16**	**2**	**-**	**100**

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- II

COURSE TITLE: Inorganic Chemistry

COURSE CODE: 22US4CHCC2INC2 [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Describe the characteristic properties of group 17, 18 elements and organometallic compounds.
2. Recognize the importance of hybridization and applications of molecular orbital theory to diatomic molecules.
3. Illustrate the synthesis and properties of main group organometallic compounds; role of metal ions in the biological system and their toxicity.

Module 1	Comparative Chemistry of group 17 and 18 elements	[12L]

Learning Objectives:

The module is intended to

1. Discuss the general trends in physical and chemical properties of group 17 and 18 elements.
2. Discuss various compounds of group 17, 18 elements.
3. Define Organometallic compounds, their classification, bonding involved and their applications.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Explain variations in the properties of group 17, 18 elements.
2. Predict structures of xenon fluorides and oxy fluorides.
3. Identify organometallic compounds and their importance of organometallic compounds.

1.1	**Comparative Chemistry of group 17 elements**	**5L**
1.1.1	General trends in their physical and chemical properties	
1.1.2	Chemistry of pseudo-halogens with respect to comparison with halogens, Preparation and uses	
1.1.3	Oxyacids of halogens	
1.2	**Comparative Chemistry of group 18 elements** History and Preparation and structure of xenon fluorides and oxy fluorides	**3L**
1.3	**Organometallic compounds**	**4L**
1.3.1	Introduction, definition, and classification on the basis of hapticity and Nature of metal-carbon (M-C) bond	
1.3.2	Eighteen Electron Rule with respect to applications and exceptions	
1.3.3	Metal carbonyls with respect to classification and bonding, General methods of preparations, properties.	
1.3.4	Applications of Organometallic compounds	

References:

- Gurudeep Raj, Advanced Inorganic Chemistry, Vol. 1.
- Gurudeep Raj, Advanced Inorganic Chemistry, Vol. 2.

Module 2	**Theories of chemical bonding – MOT and VBT**	**[12L]**

Learning Objectives:

This module is intended to

1. Discuss salient features of Molecular orbital theory.
2. Illustrate necessary conditions to be satisfied by atomic orbitals to combine together to form molecular orbitals.

3. Explain the concept of Valence bond theory, resonance energy and formal charge.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Apply the concept of MOT to homonuclear and heteronuclear diatomic molecules.
2. Illustrate the structures of various compounds based on hybridization involved on the basis of valence bond theory.
3. Compare the valence bond theory and molecular orbital theory.

2.1	**Molecular orbital theory**	**8L**
2.1.1	Salient feature of MOT	
2.1.2	LCAO – MO approach, variation of electron charge density with internuclear distance in H_2 molecule.	
2.1.3	Molecular orbitals formed by the combination of two s-orbitals, s and px orbitals. Characteristics of σ and π orbitals	
2.1.4	Necessary conditions to be satisfied by atomic orbitals to combine together to form molecular orbitals, Comparison between AO and MOs	
2.1.5	Application of LCAO-MO for the formation of homonuclear diatomic molecules. H_2, He_2, Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, Ne_2 with respect to bond order, bond length, bond energy, magnetic properties, mixing orbitals.	
2.1.6	Bond order in O_2, O_2^+, O_2^- and O_2^{2-}.	
2.1.7	Heteronuclear diatomic molecules of molecular ions CO, NO, CN^-, HCl with respect to bond order, stability, magnetic properties and polarity	
2.2	**Valence Bond Theory (VBT)**	**4L**
2.2.1	Hybridization involving the use of d orbitals as in PCl_5 (sp^3d), $BaCl_2$ (sd), and MnO_4^- (d^3s)	
2.2.2	Concept of Resonance and Resonance energy, Formal charge with examples	
2.2.3	Limitations of VBT	

References:

<table>
<tr><td colspan="3">

Satyaprakash, G. D. Tuli, S. K. Basu, Advanced Inorganic Chemistry, Vol. 1.
Satyaprakash, G. D. Tuli, S. K. Basu, Advanced Inorganic Chemistry, Vol. 2.

</td></tr>
<tr><th>Module 3</th><th>Organometallic compounds of main group elements</th><th>[12L]</th></tr>
<tr><td colspan="3">Learning Objectives:
The module is intended to
1. Describe general methods used to synthesize organometallic compounds of main group elements.
2. Explain chemistry of metallocenes.
3. Discuss Bio-inorganic chemistry with respect to essential elements in biological systems.</td></tr>
<tr><td colspan="3">Learning Outcomes:
After the successful completion of the module, the learner will be able to
1. Recognize chemical reactions of organometallic compounds.
2. Describe Structure and bonding in ferrocene on the basis of VBT.
3. Understand the role of essential and non-essential elements in biological systems.</td></tr>
<tr><td>3.1</td><td>Organometallic compounds of main group elements</td><td>5L</td></tr>
<tr><td>3.1.1</td><td>Introduction: General synthetic methods. (i) direct reaction of metals (Oxidative addition), (ii) Metal-Metal exchange (Transmetallation reactions), (iii) Carbanion-Halide exchange reaction (Metathesis), (iv) Metal-Hydrogen exchange (Metallation reaction)</td><td></td></tr>
<tr><td>3.1.2</td><td>Chemical reaction: (i) Reaction with oxygen and halogens, (ii) Alkylation and arylation reactions, (iii) Reaction with protic reagents, (iv) Redistribution reactions.</td><td></td></tr>
<tr><td>3.2</td><td>Metallocenes</td><td>7L</td></tr>
<tr><td>3.2.1</td><td>Introduction</td><td></td></tr>
<tr><td>3.2.2</td><td>Synthesis, reactions and applications of ferrocene</td><td></td></tr>
<tr><td>3.2.3</td><td>Structure and bonding in ferrocene on the basis of VBT.</td><td></td></tr>
<tr><td>3.3</td><td>Bio-inorganic Chemistry</td><td></td></tr>
<tr><td>3.3.1</td><td>Introduction, Essential and non-essential elements in biological systems</td><td></td></tr>
</table>

3.3.2	Sodium and potassium pump	
3.3.3	Role of Magnesium in Chlorophyll	
3.3.4	Role of iron in biological systems	
3.3.5	Biological functions and toxicity of a) Arsenic b) lead c) mercury d) cadmium	

References:

- Satyaprakash, G. D. Tuli, S. K. Basu, Advanced Inorganic Chemistry, Vol. 2.
- Gurudeep Raj, Advanced Inorganic Chemistry, Vol. 1.

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- II

COURSE TITLE: Inorganic Chemistry II

COURSE CODE: 22US4CHCC2INC2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	**10**	**14**	**06**	**-**	**-**	**-**	**30**
II	**08**	**12**	**10**	**-**	**-**	**-**	**30**
III	**08**	**11**	**07**	**04**	**-**	**-**	**30**
Total marks per objective	**26**	**37**	**23**	**04**	**-**	**-**	**90**
% Weightage	**30**	**41**	**25**	**4**	**-**	**-**	**100**

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- III

COURSE TITLE: Organic Chemistry

COURSE CODE: 22US4CHCC3ORC2 [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

1. Describe the synthesis, chemical reactivity and applications of aromatic aldehydes, ketones and acids.
2. Illustrate the synthesis, chemical reactivity and application of compounds containing nitrogen and epoxides.
3. Illustrate the concepts of carbohydrate chemistry.
4. Discuss the principles and applications of green chemistry; impact of chemical industry on environment.
5. Explain synthesis, properties, characterization and applications of nanomaterials.

Module 1	Aromatic aldehydes, ketones and acids	[12L]

Learning Objective:

The module is intended to describe the synthesis, chemical reactivity and applications of aromatic aldehydes, ketones and acids.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Explain how aromatic aldehydes and ketones can be prepared.

2. Describe the reactions of carbonyl group in aromatic aldehydes and ketones.
3. Illustrate the applications of aldehydes and ketones.
4. Write reactions involving syntheses of carboxylic acid, sulfonic acids.
5. Justify relative acidity of carboxylic acids based on inductive effects.
6. Explain the applications of aromatic carboxylic acids, sulfonic acids and chloro sulfonyl compounds.

1.1	**Aromatic aldehydes and ketones**	**6L**
1.1.1	Preparation of aromatic aldehydes: Gattermann reaction, Gattermann- Koch reaction, Vilsmeier Haack reaction, Reimer-Tiemann reaction. Rosenmund reduction,	
1.1.2	Preparation of aromatic ketones: Friedel-Crafts acylation using acid chloride and acid anhydride.	
1.1.3	Reactions: Knoevenagel reaction, Claisen-Schmidt reaction, Benzoin reaction, Cannizzaro reaction (mechanism).	
1.1.4	Applications of aromatic aldehydes and ketones.	
1.2	**Aromatic carboxylic acids**	**4L**
1.2.1	Preparation: From alkyl benzenes, Solid carbon dioxide, Aryl nitriles and Kolbe-Schmidt reaction with mechanism.	
1.2.2	Effect of substituents on the acidity of benzoic acid	
1.2.3	Reactions: esterification by alkylation, Reduction and decarboxylation.	
1.2.4	Applications of aromatic carboxylic acids.	
1.3	**Aromatic sulfonic acids**	**2L**
1.3.1	Preparation: Sulfonation of benzene (with mechanism) and naphthalene.	
1.3.2	Acidity of arene sulfonic acids. Comparative acidity of carboxylic acids and sulfonic acids.	
1.3.3	Reactions: desulfonation.	
1.3.4	Aromatic chlorosulfonyl compounds. Preparation: Using chlorosulfonic acid.	
1.3.5	Reaction with water, ammonia and amines.	

1.3.6	Uses of – pTSA and sulfonated polystyrene.	
References: - Morrison R.T. and Boyd, R.N. Organic chemistry, Dorling Kindersley (India) pvt. Ltd. (Pearson Education), 2012. - Mc Murry, J. E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. - B. Y. Paula Organic Chemistry 8th edition, Pearson, 2020.		
Module 2	**Nitrogen containing compounds, epoxides and carbohydrates**	**[12L]**
Learning Objective: This module is intended to discuss the general structure, nomenclature, chemical reactions and applications of nitrogen containing compounds, epoxides and carbohydrates.		
Learning Outcomes: After the successful completion of the module, the learner will be able to 1. Explain the chemical reactivity of compounds containing nitrogen. 2. Write the preparation and reactions of epoxides. 3. Define and classify carbohydrates. 4. Discuss the stereochemistry and reactivity of carbohydrates. 5. Distinguish between the anomers and epimers of monosaccharides.		
2.1	**Nitrogen containing compounds**	**5L**
2.1.1	**Aromatic nitro Compounds:** Reactions: Reduction of nitro compounds under acidic, basic and neutral conditions.	
2.1.2	**Aromatic amino compounds:**	
2.1.2.1	Preparation: Amination of halobenzenes, Chemoselective reduction of dinitrobenzene, Hoffmann bromamide reaction.	
2.1.2.2	Basicity of aromatic amines	
2.1.2.3	Reactions: N-alkylation, N-acylation, halogenation, reductive alkylation.	

2.1.3	**Diazonium Compounds:**	
2.1.3.1	Preparation: From aromatic primary amines with mechanism	
2.1.3.2	Reactions: Gomberg reaction, Replacement of diazo group by -H, -OH, -CN, Azo-coupling reaction with phenols/naphthols and aromatic amines, Reduction of diazonium salt to aryl hydrazine. Formation of azo- and hydrazo benzenes.	
2.2	**Epoxides**	**3L**
2.2.1	Preparation: from olefins - using per acid and from vicinal halohydrins.	
2.2.2	Reactivity of epoxides	
2.2.3	Reactions: Ring opening reactions by nucleophiles (a) In acidic conditions; hydrolysis, reaction with – HX, alcohol, HCN. (b) In neutral or basic conditions: ammonia, amines, metal cyanides, Grignard reagents, alkoxides.	
2.2.4	Applications of epoxides (including chiral epoxides)	
2.3	**Carbohydrates**	**4L**
2.3.1	Introduction: Classification, sources, reducing and non-reducing sugars, D & L configurational assignment.	
2.3.2	Structures of monosaccharides: Fischer projection formula and Haworth projection formula - Furanose and pyranose forms of pentoses and hexoses. Interconversion: open and Haworth forms of monosaccharides with 5 and 6 carbons	2.3.2
2.3.3	Anomers and epimers of monosaccharides. Enantiomers and diastereomers of glucose. Mutarotation (with mechanism) in D-glucose.	2.3.3
2.3.4	Chain lengthening and shortening reaction: Modified Kiliani-Fischer synthesis, Wohl method.	2.3.4
2.3.5	Interconversion of D-glucose and D- fructose	2.3.5
References:		

• Morrison R.T. and Boyd, R.N. Organic chemistry, Dorling Kindersley (India) pvt. Ltd. (Pearson Education), 2012. • Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013. • B.Y. Paula Organic Chemistry 8th edition, Pearson, 2017.		
Module 3	**Green Chemistry**	**[12L]**
Learning Objective: The module is intended to discuss the basic concepts of green chemistry, the newer methods of synthesis and environmental aspects.		
Learning Outcomes: After the successful completion of the module, the learner will be able to 1. Explain the basic principles of green chemistry with suitable examples. 2. Calculate the atom economy of given reactions. 3. Describe the green synthesis of some processes. 4. Discuss the environmental issues arising due to chemicals and chemical industries.		
3.1	**Basic Principles** Definition, need, importance, twelve principles of Green Chemistry (with relevant examples), concepts and simple calculations on yield and selectivity, E-factor, atom economy. Examples of Green Chemistry in Industry. a) Green reactions- halide free synthesis of aromatic amines. b) Green chemistry and catalysis - Novel homogenous, heterogeneous and enzymatic catalysts in industry. i) Catalytic liquid phase selective hydrogenation of nitrobenzene to p-aminophenol	**5L**

	ii) Liquid phase air oxidation of p-cresol to p-hydroxybenzaldehyde	
3.2	**Newer Methods of Synthesis**	**3L**
3.2.1	The use of phase transfer catalysis and polymer support	
3.2.2	Synthesis using microwave and ultrasound.	
3.3	**Environmental Aspects**	**4L**
3.3.1	Greenhouse effect, important greenhouse gases and their sources (Six important sources). Global warming potential, impact on climate change, climate change mitigation through carbon capture & storage.	
3.3.2	Hydrocarbons as air pollutants (PCB, VOC, PHC)	

References:

- Green Chemistry An Introductory Text: Mike Lancaster, 2nd Edition, RSC Publishing, 2010.
- Green Chemistry: V. K. Ahluwalia (Narosa Publishing House Pvt. Ltd.), 2020
- New Trends in Green Chemistry V. K. Ahluwalia, M. Kidwai, Kluwer Academic Publisher and Anamaya Publishers, 2004.

Module 4	**Nanochemistry - an emerging science (Optional)**	**[12L]**

Learning Objective:

The module is intended to provide a broad overview of fundamental principles, different types of nanomaterials, methods of preparation, and applications of nanomaterials.

Learning Outcomes:

After the successful completion of the module, the learner will be able to

1. Describe scope and importance of nano materials and nanotechnology.
2. Explain the different properties of nano materials and applications of nano materials in different areas of science and medical field.

4.1	**Introduction** What are nanomaterials? Different types of nano-materials	**1L**
4.2	**Methods of preparation** Top to bottom approach and bottom to top approach, Arc method, Laser method, Chemical vapour deposition	**3L**

4.3	**Properties** Electrical properties, optical properties, mechanical properties, surface properties, High Aspect ratio	4L
4.4	**Typical characterization techniques** SEM. TEM, AFM	2L
4.5	**Applications** Medicinal, Electronics, Research and Environmental	2L

References:

- Principles of Nanotechnology by Sulabha Kulkarni Sixth Edition, 2010
- Concepts of Nanochemistry by Ludovico Cadmartiri, G. A. Ozin, Jean- Mary Lehn . Wiley Publications, 2009.

Question Paper Template

S.Y. B. Sc. (CHEMISTRY) SEMESTER IV

Core Course- III

COURSE TITLE: Organic Chemistry II

COURSE CODE: 22US4CHCC3ORC2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	12	7	7	4	--	--	30
II	9	7	7	7	--	--	30
III	11	12	4	3	--	--	30
Total marks per objective	32	26	18	14	--	--	90
% Weightage	36	29	20	15	--	--	100

S. Y. B. Sc. (CHEMISTRY)

SEMESTER IV - Practical

COURSE CODE: 22US4CHCCP **Credit- 03**

Learning Objectives:

The practical is intended to

1. Investigate the order of reactions, molecular weight of polymers and Nernst Distribution Law.
2. Discuss the volumetric and gravimetric estimation
3. Discuss elemental analysis of organic Compounds

Learning Outcome:

After the successful completion of the practical, the learner will be able to

1. Predict the order of reaction, molecular weight of polymers and Distribution coefficient.
2. Perform the volumetric and gravimetric analysis
3. Identify unknown organic compounds by using qualitative analysis (Organic spotting).

Core Course I	Physical Chemistry II
1. To determine the rate constant for hydrolysis of methyl acetate by HCl and show	

that it is a first order reaction.

2. To determine the order of the reaction Potassium persulphate and KI by fractional change method.
3. To determine the ΔG_o and equilibrium constant for the cell reaction in the cell set up with Silver and Copper electrodes. (Cu – Ag) cell
4. To determine partition coefficient of iodine between water and carbon tetrachloride
5. To determine the molecular weight of polyvinyl alcohol (PVA) from viscosity measurements.

Core Course II	**Inorganic Chemistry II**

1. Gravimetric Analysis

i. Estimation of Fe^{+3} from a solution of ferric alum by redox titration.
ii. Determination of volume strength of hydrogen peroxide using $KMnO_4$.
iii. Estimation of Cu^{+2} from a solution of $CuSO_4.5H_2O$ by iodometry.

2. **Volumetric Analysis**

i. Barium as $BaSO_4$ from a given solution of $BaCl_2.2H_2O$
ii. Fe as Fe_2O_3 from a given solution of ferrous ammonium sulphate.
iii. Zn as $Zn_2P_2O_7$ from a given solution of $ZnCl_2.2H_2O$ or $ZnSO_4.2H_2O$

Core Course III	**Organic Chemistry II**

Organic Spotting

Identification of organic compounds

References:

- Experimental Physical Chemistry, V. D. Athawale, 2007 New Age International Publishers.
- Svehla, G. Vogel’s Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book

of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.