

M. Sc. (CHEMISTRY) SEMESTER II

Core Course-I

COURSE TITLE: INORGANIC CHEMISTRY

COURSE CODE: CC201[CREDITS - 04]

Course Learning Outcome		
After the successful completion of the Course, the learner will be able to: <ol style="list-style-type: none"><li>1. Define magnetic properties of different types of magnetic bodies</li><li>2. Determine magnetic susceptibility and understand its applications, and solve problems involving applications of magnetic moment.</li><li>3. Classify and describe the structures and bonding of metal carbonyls and nitrosyls.</li><li>4. Explain vibrational spectra for bonding and structure elucidation and preparation of metal carbonyls and nitrosyls.</li><li>5. Describe the bioinorganic chemistry of structure and function of bioinorganic complexes containing Fe, Cu and Zn.</li><li>6. Discuss the functions of metal complexes in Medicine and anticancer activity of Platinum complexes.</li><li>7. Differentiate the structure and functions between Hemoglobin, Hemocyanin and Myoglobin.</li><li>8. Classify coordination compounds and discuss Werner's theory to explain electronic interpretation, and factors affecting the formation of complex ions</li><li>9. Describe detection of complex ion in solution</li><li>10. Discuss the stability of metal chelates and discuss importance of chelates, and role of metal chelates in living system</li></ol>		
<b>Module 1</b>	<b>ELEMENTS OF MAGNETOCHEMISTRY</b>	<b>[15L]</b>
<b>Learning Objectives:</b> <p>This module is intended to</p> <ul style="list-style-type: none"><li>• Acquire knowledge of magnetic properties and sources of paramagnetism and diamagnetism.</li></ul>		
<b>Learning Outcome:</b> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"><li>• Define the definitions of magnetic properties,</li><li>• Differentiate types of magnetic bodies,</li><li>• Determine magnetic susceptibility and understand its applications</li><li>• Solve problems involving applications of magnetic moment.</li></ul>		
<b>1.1</b>	Elements of magneto chemistry: Definitions of magnetic properties, type of magnetic bodies, the source of paramagnetism, diamagnetism and Pascal's constant, Example of Pascals constant. Curie and Curie- Weiss law, Magnetic Properties of transition elements. Determination of magnetic susceptibility:  (a) Gouy method (b) Faraday method (c) Null deflection method.  Application of magnetic susceptibility measurements, Temperature independent paramagnetism (TIP), Orbital contribution to magnetic moment.	

Module 2	METAL $\pi$ -COMPLEXES	[15L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Make the students understand structure, bonding and synthesis of metal carbonyls and nitrosyls.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Classify metal carbonyls and nitrosyls.</li> <li>• Describe structure and bonding of metal carbonyls and nitrosyls.</li> <li>• Explain vibrational spectra for bonding and structure elucidation.</li> <li>• Explain preparation of metal carbonyls and nitrosyls.</li> </ul>		
1.2	<p>Metal carbonyls: Introduction, classification of metal carbonyls, structure and bonding, vibrational spectra studies for bonding and structure elucidation. Preparation of metal carbonyls by (1) Direct synthesis and (2) Metal compounds. Preparation, properties and structure of Ni(CO)<sub>4</sub>, Fe<sub>2</sub>(CO)<sub>9</sub> and Co<sub>2</sub>(CO)<sub>8</sub>, 18-electron rule and EAN of metal carbonyls. Metal Nitrosyls: Introduction, coordination compounds of metal nitrosyls, preparation properties of nitrosyl compounds like nitrosyl halides, nitrosyl cyanides, hydroxides and nitrosyl aquo compounds Complex of NO<sup>+</sup> iron, EAN and structures of nitrosyls.</p>	
Module 3	BIOINORGANIC CHEMISTRY	[15L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to make the students</p> <ul style="list-style-type: none"> <li>• Learn the biological chemistry of Iron, Copper and Zinc.</li> <li>• Understand the biological chemistry of Copper, and Metal complexes in medicine and anticancer activity of complexes.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Describe the bioinorganic chemistry of structure and function of Hemoglobin, Myoglobin, Ferritin and Transferrin.</li> <li>• Discuss the functions metal complexes in Medicine and anticancer activity of Platinum complexes.</li> <li>• Differentiate the functions between Hemoglobin, Hemocyanin, Myoglobin</li> <li>• Distinguish the structure and function between blue-copper proteins and non-blue copper proteins</li> </ul>		

<b>1.3</b>	<p>[A] Biochemistry of Iron: Transport of Iron, Hemoglobin and Myoglobin; Storage and Transport of Iron viz. Ferritin and Transferrin, Cytochromes, Iron-Sulfur Proteins.</p> <p>[B] Biochemistry of Copper: Structural features of different Cu-Proteins, Blue Copper Proteins (Plastocyanin, Azurins and Blue Oxidases), Non-blue copper proteins (Galactose Oxidase, Amine Oxidase).</p> <p>[C] Biochemistry of Zinc: Carboxypeptidase and carbonic anhydrase.</p> <p>[D] Metal complexes in Medicine: Disease due to metal deficiency and its treatment: Fe, Cu, Zn and Mn, metals used in diagnosis: MRI</p> <p>[E] Anticancer activity of Platinum complexes.</p>	
<b>Module 4</b>	<b>COORDINATION CHEMISTRY</b>	<b>[15L]</b>

**Learning Objectives:**

This module is intended to

- Make the students aware about the basic principles coordination chemistry, Werner's Theory, differentiation between complexes and chelates, describe their structure, and different applications

**Learning Outcome:**

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

- Classify coordination compounds and explain Werner's theory
- Explain electronic interpretation, and factors affecting the formation of complex ions
- Describe detection of complex ion in solution,
- Analyze stability of metal chelates and discuss importance of chelates,
- Explain role of metal chelates in living system

<b>1.4</b>	<p>Classification of coordination compounds, Werner's theory of coordination, Electronic interpretation of coordination compounds, Factors effecting the formation of complex ions, Detection of complex ion in solution, Chelation, Factors influencing the stability of metal chelates, Importance of chelates, Role of metal chelates in living system. Inner complexes and polynuclear complexes, Determination of composition of complex ions.</p>	
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**References:**

1. Advanced Inorganic Chemistry by F. A Cotton and R.G. Wilkinson, John Wiley & Sons, N. Y.
2. Principles of Inorganic Chemistry, by Puri. Sharma and Kalia, 33rd Edition, Vishal publishing Co. Jalandhar, Dehli, 2017.
3. Advanced Inorganic Chemistry by S. K. Agarwala and Keemtilal, Pragati Prakashan, Meerut.
4. Advanced Inorganic Chemistry, Volume-II by Gurdeep Raj, Krishna Prakashan Media Ltd., Meerut.
5. Inorganic Chemistry by Gary L Miessler and Donald A. Tarr, Pearson Education Int.
6. F. Wells, Structural Inorganic Chemistry - 5<sup>th</sup> edition (1984).
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9. Inorganic Chemistry 3rd ed. D. F. Shriver and P. W. Atkins, Oxford University Press, 1999, Chapter 16.

10. Organotransition Metal Chemistry, Anthony F. Hill, Royal Society of Chemistry, Tutorial Chemistry Text, 2002. Chapters 1 to 7.
11. Organotransition Metal Chemistry: Applications to Organic Synthesis, S. G. Davies, Pergamon 1982.
12. Bioinorganic Chemistry: A Short Course-Rosette M. Roat-Malone, Wiley Inter science, 2002.
13. Bioinorganic Chemistry by Asim K. Das, Books and Allied (P) Ltd.
14. Biological Inorganic Chemistry – An Introduction, Robert Crichton, Elsevier Sc. 2007.
15. The Biological Chemistry of Elements – The Inorganic Chemistry of Life, J. J. R. Frausto da Silva and R. J. P. Williams, Clarendon Press, Oxford 1991.

### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√		√	√	√				
2.	√	√	√								
3.	√		√	√							
4.	√	√	√								
5.		√			√	√		√			
6.	√	√	√								
7.	√		√	√							
8.	√		√					√			
9.	√	√	√			√					
10.	√	√	√		√	√					



**M. Sc. (CHEMISTRY) SEMESTER II**  
**Core Course-II**  
**COURSE TITLE: ORGANIC CHEMISTRY**  
**COURSE CODE: CC202[CREDITS - 04]**

**Course Learning Outcome**

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

1. Comprehend the step-by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement.
2. Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions.
3. Define aromaticity and describe its significance in organic chemistry, to determine aromatic character in organic compounds and apply Frost circle diagrams to predict aromatic behavior.
4. Explain the structure and stability of benzene and its derivatives, analyze the factors contributing to the stability of aromatic compounds compared to non-aromatic counterparts.
5. Discuss and compare the aromatic behavior of various compounds such as benzenoid and non-benzenoid, azulene, and annulenes.
6. Recall the names, structures, and basic properties of the listed organic transformations and reagents and comprehend the mechanisms, principles, and applications of the organic transformations and reagents, explaining how they function in various chemical contexts.
7. Apply their knowledge of organic transformations and reagents to predict reaction outcomes, propose synthetic routes, and solve problems in organic synthesis.
8. Analyse reaction mechanisms, intermediates, and stereochemical aspects of the listed transformations, identifying key steps and determining their significance in overall synthetic strategies.
9. Define and explain the fundamental principles of photochemistry, including the interaction of molecules with light, electronic excitation, and the mechanisms of photochemical reactions.
10. Recognize and describe photophysical processes such as fluorescence, phosphorescence, and intersystem crossing, which govern the behavior of molecules upon exposure to light.

**Module 1**

**ORGANIC NAME REACTIONS**

**[15L]**

**Learning objectives:**

This module is intended to learn general nature, mechanism and synthetic application of various name reactions.

**Learning outcomes:**

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

- Comprehend the step-by-step mechanisms involved in each reaction, including bond formation, bond breaking, and electron movement.
- Apply the above knowledge to design efficient synthetic routes to target molecules by strategically selecting appropriate starting materials and reaction conditions.

<b>2.1</b>	General nature, method, mechanism and synthetic applications of the following reactions: (i) Arndt Eistert reaction (ii) Dakin reaction (iii) Darzen's glycidic ester synthesis (iv) Willgerodt reaction (v) Leucart reaction (vi) Heck reaction (vii) Suzuki reaction (viii) Buchwald-Hartwig reaction (ix) Sonagashira reaction (x) H. V. Z. reaction	
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**Module 2****AROMATICITY****[15L]****Learning Objectives:**

This module aims to enable students to

- Comprehend aromaticity principles, analyze structural stability, predict aromatic behavior using theoretical models,
- Evaluate experimental methods, compare different aromatic compounds, critically assess aromaticity in complex molecules, design synthetic strategies, communicate effectively, in aromatic chemistry.

**Learning Outcome:**

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

- Define aromaticity and describe its significance in organic chemistry, to determine aromatic character in organic compounds.
- Explain the structure and stability of benzene and its derivatives, analyze the factors contributing to the stability of aromatic compounds compared to non-aromatic counterparts.
- Apply Frost circle diagrams to predict aromatic behavior
- Compare the aromatic behavior of various compounds such as benzenoid and non-benzenoid, azulene, and annulenes.



2.2	Aromaticity and aromatic character; modern theories of structure and stability of benzene, concept of aromaticity; Resonance and chemical stabilization; criteria to check aromatic character-IR, UV & NMR, heat of hydrogenation; Huckel's rule; Huckel Molecular Orbital (HMO) theory, Frost Circle method to prepare MO Diagram for cyclic polyenes, Resonance Energy per $\pi$ -Electron (REPE) Antiaromaticity, Homoaromaticity, Nonaromaticity, Benzenoid Aromatic compounds and Heteroaromatic compounds: naphthalene, pyrene. Aromaticity Non- Benzenoid aromatic compounds: Azulene (Craig's rule), Tropolones, Charged rings, Annulenes, Fullerenes, Meso-ionic compounds	
<b>Module 3</b>	<b>ORGANIC TRANSFORMATION AND REAGENTS</b>	<b>[15L]</b>
<b>Learning Objectives:</b> This module is intended to <ul style="list-style-type: none"><li>• Comprehend the mechanisms, applications, and limitations of various organic transformations and reagents.</li><li>• Explore the use of different reagents and methodologies for specific organic transformations.</li><li>• Analyze and predict the mechanisms of organic reactions involving the listed reagents and transformations, enhancing problem-solving skills in organic chemistry.</li></ul>		
<b>Learning Outcome:</b> After the successful completion of the module, the learner will be able to <ul style="list-style-type: none"><li>• Recall the names, structures, and basic properties of the listed organic transformations and reagents.</li><li>• Comprehend the mechanisms, principles, and applications of the organic transformations and reagents, explaining how they function in various chemical contexts.</li><li>• Apply their knowledge of organic transformations and reagents to predict reaction outcomes, propose synthetic routes, and solve problems in organic synthesis.</li><li>• Analyse reaction mechanisms, intermediates, and stereochemical aspects of the listed transformations, identifying key steps and determining their significance in overall synthetic strategies.</li></ul>		



2.3	<ol style="list-style-type: none"><li>1) Sharpless epoxidation</li><li>2) Umpolung reagent (1,3-dithiane)</li><li>3) Dess martin periodinane</li><li>4) DDQ</li><li>5) Sodium Borohydride (<math>\text{NaBH}_4</math>)</li><li>6) Di-isobutyl aluminum hydride (DIBAL-H)</li><li>7) Lithium diisopropylamide (LDA)</li><li>8) Try-n-Butyl tinhydride (<math>\text{C}_4\text{H}_9</math>)<sub>3</sub>SnH</li><li>9) Sodium cyanoborohydride (<math>\text{NaBH}_3\text{CN}</math>)</li><li>10) Wilkinson's Catalyst</li><li>11) Grignard reagents</li></ol>	
<b>Module 4</b>	<b>PHOTO CHEMISTRY</b>	<b>[15L]</b>
<b>Learning objectives:</b>		
This module is intended to <ul style="list-style-type: none"><li>• Understand photochemistry, various types of its reaction, photochemical cleavage of carbonyl compounds, their mechanism and application in synthesis</li></ul>		
<b>Learning outcomes:</b> <p>After the successful completion of the module, the learner will able to</p> <ul style="list-style-type: none"><li>• Define and explain the fundamental principles of photochemistry, including the interaction of molecules with light, electronic excitation, and the mechanisms of photochemical reactions.</li><li>• Recognize and describe photophysical processes such as fluorescence, phosphorescence, and intersystem crossing, which govern the behavior of molecules upon exposure to light.</li></ul>		
2.4	[A] Energy of molecules, photochemical energy, electronic excitation, Jablonski diagram, laws of photochemistry, quantum efficiency. [B] Photochemistry of carbonyl compounds- $\alpha$ -cleavage of acyclic, cyclic and $\alpha$ - $\beta$ unsaturated cleavage of carbonyl compounds, $\beta$ -cleavage of inter and intramolecular hydrogen abstraction, addition to carbon-carbon double bond, photo reduction of carbonyl compounds. [C] Photo induced rearrangement of enones, dienones and alkenes. Photochemistry of alkenes and aromatic compounds-isomerization, dimerization and addition reactions.	



### References:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Reaction Mechanism in Organic Chemistry by S. M. Mukherji and S. P. Singh (McMillan India Ltd., 1976).
3. Organic Chemistry (3/e) by J. B. Hendrickson, Donald J. Crem and George S. Rammond (McGraw-Hill Book Co. & Kogekusha Co. Ltd., 1970).
4. Organic Chemistry (5/e) by Morrison & Boyd (Prentice Hall).
5. Advanced Organic Chemistry by Carey & Sundberg (3<sup>rd</sup> edition).
6. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
7. Name Reactions by A. R. Parikh & H. A. Parikh
8. Name reaction: A collection of detailed reaction mechanism by Jie Jack Li
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10. Organic Chemistry-Reactions and Mechanism by P S Kalsi
11. Advanced Organic Chemistry: Reactions and Mechanisms by M. S. Singh
12. Organic chemistry by Cram, Hammond, Pine and Handrickson
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16. Pericyclic reactions: A text book by S. Sankararaman
17. Excited states in Organic Chemistry by J. D. Coyle and J. A. Barltrop.



### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√									
2.	√	√		√		√	√				
3.	√	√					√				
4.	√	√			√	√	√				
5.	√	√					√				
6.	√	√	√	√		√	√				
7.	√	√		√	√	√	√				
8.	√	√		√	√	√	√				
9.	√	√			√						
10.	√	√									



## M. Sc. (CHEMISTRY) SEMESTER II

### Core Course-III

### COURSE TITLE: PHYSICAL CHEMISTRY II

### COURSE CODE: CC203 [CREDITS - 04]

#### Course Learning Outcome

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

1. Describe the conductance of electrolytes in solutions, explain importance of polarization, relaxation effect, electrophoretic effect, decomposition potential and over voltage in electrolysis process and relate its application in industries.
2. Solve numerical problems involving activity coefficient, ionic strength and other similar parameters
3. Explain the fundamental aspects of surface chemistry and describe & illustrate monolayer and multilayer adsorption and its isotherm graphs and BET and Gibb's adsorption isotherms.
4. Describe the origin of intermolecular and surface forces between gases and solid interfaces.
5. Recognize colloids types and preparation methods, colloidal electrical properties the formation of the electrical double layer, and analyze factors influencing zeta potential.
6. Apply electrophoresis and DLVO theory to determine zeta potential and colloidal stability, discuss surfactant types and their effects.
7. Identify the types of radiation in the atomic and molecular spectroscopy and discuss its various types.
8. Discuss the fundamentals of rotational spectroscopy with example of linear rigid diatomic molecules, symmetric tops, spherical tops, asymmetric tops and effect of isotopic substitution.
9. Discuss IR Spectroscopy and determine force constant, Amplitude of vibration, The anharmonic oscillator, Morse potential, vibrational transitions.
10. Explain and differentiate Vibrational – Rotational spectra of diatomic molecule (CO molecule) and apply Vibrational rotational spectra in elucidation of structure, solve problems (Numericals) related to Molecular spectroscopy.

**Module 1**

**THEORIES OF ELECTROLYTIC CONDUCTANCE AND  
OVER VOLATEGE**

**[15L]**

#### Learning Objectives:

This module is intended to

- Acquire knowledge of conductivity behavior of strong electrolytes in solution, factors affecting electrolysis process.



### Learning Outcome:

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

- Describe the conductance of electrolytes in solutions. Explain importance of polarization, relaxation effect, electrophoretic effect etc.
- Define decomposition potential and over voltage in electrolysis process and relate its application in industries
- Determine experimentally the activity coefficient, dissociation constants and over voltage
- Solve numerical problems involving activity coefficient, ionic strength and other similar parameters.

3.1

Theories of electrolytic conductance and over voltage: Debye-Hückel theory of strong electrolytes, relaxation effect and Electrophoretic effect, Debye-Falkenhagen effect, Wein effect. Ionic strength and its determination, Debye-Hückel limiting law. Activity and activity coefficient, determination of activity coefficient by (i) solubility (solubility product principle) (ii) EMF method (cell without transference), Determination of dissociation constant of monobasic acid by conductance method and approximate EMF method, Electrolytic polarization, Dissolution and Decomposition potential, Concentration polarization, Decomposition potential and its determination, over voltage, determination of over voltage, theories of over voltage: combination of atom as slow process (Tafel theory), Numericals.

Module 2

**SURFACE CHEMISTRY**

[15L]

### Learning Objectives:

This module is intended to

- Understand the basics of adsorption and surface chemistry from the physical-chemical perspective.
- Understand the phenomenon occurring on the surfaces of adsorbent during the sorption process.
- Learn solving numerical

### Learning Outcome:

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

- Explain the fundamental aspects surface chemistry.
- Differentiate the monolayer and multilayer adsorption and its isotherms
- Describe the different adsorption isotherm graphs.
- Describe and illustrate derivation of BET and Gibb's adsorption isotherm.
- Describe the origin of intermolecular and surface forces between gases and solid interfaces.
- Describe the concept of interfacial energy and surface pressure.



3.2	Adsorption, multilayer adsorption, the BET adsorption isotherms, derivation of BET equation, determination of surface area and area of cross section of molecules by BET equation. Derivation of Langmuir equation from BET equation. Explanation of different adsorption isotherms, change in enthalpy, entropy and free energy of adsorption, adsorption at the surface of liquid: Gibbs adsorption isotherms (derivation). Thermodynamic treatment of adsorption, surface active substances and surface inactive substances, orientation of surfactants on the surface of solution, surface pressure, insoluble surface films on liquid, Numericals.	
<b>Module 3</b>	<b>COLLOIDS</b>	<b>[15L]</b>
<b>Learning Objectives:</b>		
<p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Understand types of Colloids and discuss their preparation and properties.</li> <li>• Discuss formation of electrical double layer and its various theories.</li> <li>• Determination of zeta potential using electrophoresis and factors affecting it</li> <li>• Discuss DLVO theory and how it affects stability of colloids.</li> <li>• Discuss electro kinetic properties.</li> <li>• Understand surfactants and its types.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Recognize colloids types and preparation methods,</li> <li>• Comprehend colloids electrical properties and the formation of the electrical double layer, and analyse factors influencing zeta potential.</li> <li>• Apply electrophoresis to determine zeta potential, apply DLVO theory to assess colloids stability, and understand surfactant types and their effects.</li> <li>• Evaluate theories explaining the double layer formation and surfactant effectiveness.</li> </ul>		
3.3	Types of colloids systems, preparation of lyophobic colloids, Properties of Colloids systems: (i) electrical properties origin of charges on colloids, Helmholtz-Perin, Guoy-Chapmann and Stern theory electrical double layer, Zeta potential and its determination by electrophoresis, factor affecting zeta potential, Explanation and derivation DLVO theory of colloid stability (ii) Electrokinetic properties: Electrophoresis, electro-osmosis. Surface active agents, critical micellar concentration (CMC), factors affecting the CMC of surfactants, thermodynamics of micellization: mass action and phase separation model, solubilization, emulsion, types of emulsion, methods for determination of types of emulsion, microemulsion, types of microemulsion, theories of microemulsion.	

**Module 4****MOLECULAR SPECTROSCOPY****[15L]****Learning Objectives:**

This module is intended to

- Make the students familiar with fundamentals of spectroscopic methods such as microwave, IR and Raman spectrometry.
- Analyze and interpret the data without any ambiguity.

**Learning Outcome:**

- Identify the types of radiation in the atomic and molecular spectroscopy and discuss its various types.
- Discuss the fundamentals of rotational spectroscopy with example of linear rigid diatomic molecules, symmetric tops, spherical tops, asymmetric tops and effect of isotopic substitution.
- Explain techniques of instrumentation of rotational spectrum.
- Discuss IR Spectroscopy and determine force constant, Amplitude of vibration, The anharmonic oscillator, Morse potential, vibrational transitions.
- Explain and differentiate Vibrational – Rotational spectra of diatomic molecule (CO molecule) and apply Vibrational rotational spectra in elucidation of structure.
- Solve problems (Numericals) related to Molecular spectroscopy.

**3.4**

Molecular spectra, Microwave spectroscopy (Rotational spectroscopy): The Rotation of molecules, Linear molecule, Symmetric tops, Spherical tops, Asymmetric tops, Rotational spectra of rigid diatomic molecule, Intensities of spectral lines, Effect of isotopic substitution, Techniques and instrumentation of rotational spectrum, IR Spectroscopy: Classical frequency of harmonic oscillator, The classical potential energy of harmonic vibration of a diatomic molecule, Quantum expression of potential energy, energy level diagram, Relative population of energy levels, Mechanism of interaction with radiation, selection rule, determination of force constant, Amplitude of vibration, The anharmonic-vibration or oscillator, Morse potential, Vibrational energy of diatomic molecule following the Morse potential, energy level diagram, vibrational transitions. Vibrational – Rotational spectra of diatomic molecule (CO molecule) Application of Vibrational rotational spectra Numerical

**References:**

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2. Group theory and its application by P.K. Bhattacharya, Himalaya publishing hours, Mumbai, 1986
3. Group theory and symmetry by L. R. hall, McGraw hill, New York, 1989.
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5. Introductory Quantum Chemistry (Third edition) by N. W. Hanna, Benjamin, Menlo Park, Calif, 1988.



6. Quantum Chemistry and Spectroscopy by M. S. Pathania, Vishal Publications India, 1981.
7. Kinetic and Mechanism' by A. A. Frost and R. G. Pearson, Wiley, New York, 1961.
8. Mechanism of Inorganic Reactions by F. Basolo and R.G. Pearson, Second Edition, Wiley Eastern Limited, New Delhi, 1977.
9. Advanced Inorganic Chemistry by F. A Cotton and R.G. Wilkinson, John Wiley & Sons, N. Y.
10. Principles of Inorganic Chemistry, by Puri. Sharma and Kalia, 33rd Edition, Vishal publishing Co. Jalandhar, Dehli, 2017.
11. Advanced Inorganic Chemistry by S. K. Agarwala and Keemtilal, Pragati Prakashan, Meerut.
12. Advanced Inorganic Chemistry, Volume-II by Gurdeep Raj, Krishna Prakashan Media Ltd., Meerut.
13. Inorganic Chemistry by Gary L Miessler and Donald A. Tarr, Pearson Education International

### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√				√				
2.	√		√				√				
3.	√	√	√				√	√			
4.	√	√	√				√				
5.	√	√	√		√						
6.	√	√	√		√		√				
7.	√	√	√				√				
8.	√	√	√				√				
9.	√	√	√		√		√				
10.	√	√	√		√	√	√				



## M. Sc. (CHEMISTRY) SEMESTER II

### Elective Course-II

### COURSE TITLE: ANALYTICAL CHEMISTRY III

### COURSE CODE: EC201 [CREDITS - 04]

Course Learning Outcome		
After the successful completion of the Course, the learner will be able to:		
<ol style="list-style-type: none"><li>1. Define and explain the basic concept, types and theories of chromatography.</li><li>2. Explain instrumentation of GC and its different components.</li><li>3. Discuss basic concepts, columns and detectors of HPLC.</li><li>4. Define and explain the basic concept X-ray spectroscopy, XRF and XRD.</li><li>5. Explain instrumentations, ion sources and detectors in mass spectrometry.</li><li>6. Discuss basic concepts, principles and application of Radio analytical methods.</li><li>7. Explain the basic concepts, compare the advantages/disadvantages and applications of SEM, STM and TEM.</li><li>8. Explain the basic concepts, limitations, advantages and applications of AAS.</li><li>9. Explain the fundamental concepts and applications of Ion selective, electrodes polarography, electrogravimetry and coulometry.</li><li>10. Describe the ion-selective electrodes and bio-catalysed membranes in polarography.</li></ol>		
<b>Module 1</b>	<b>CHROMATOGRAPHY</b>	<b>[15L]</b>
<b>Learning Objectives:</b>		
This module is intended to		
<ul style="list-style-type: none"><li>• To gain knowledge of the chromatography techniques and its applications.</li></ul>		
<b>Learning Outcome:</b>		
After the successful completion of the module, the learner will be able to		
<ul style="list-style-type: none"><li>• Define and explain the basic concept, types and theories of chromatography.</li><li>• Explain instrumentation of GC and its different components.</li><li>• Discuss basic concepts, columns and detectors of HPLC.</li></ul>		
<b>4.1</b>	<b>Basic concepts and theories of chromatography:</b> Introduction and Classification of chromatographic methods, Concept of plate and rate theories in chromatography, efficiency, resolution, selectivity and separation capability, Van Deemter equation and broadening of chromatographic peaks. Optimization of chromatographic conditions.	



	<p><b>Gas Chromatography:</b> Instrumentation –sample injection systems (split/split less), column types (solid/ liquid stationary phases), column switching techniques, temperature programming, Requirements of an ideal detector and types of detectors in GLC and GSC, Applications -Qualitative and quantitative analysis.</p> <p><b>High Performance Liquid Chromatography (HPLC)</b> Normal phase and reversed phase with special reference to types of commercially available columns (Use of C8 and C18 columns). Diode array type and fluorescence detector. Applications of HPLC.</p>	
<b>Module 2</b>	<b>INSTRUMENTAL METHODS-II</b>	<b>[15L]</b>
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Understand fundamental concepts of X-ray spectroscopy, mass spectrometry and radio analytical techniques and their applications.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Define and explain the basic concept X-ray spectroscopy, XRF and XRD.</li> <li>• Explain instrumentations, ion sources and detectors in mass spectrometry.</li> <li>• Discuss basic concepts, principles and application of Radio analytical methods.</li> </ul>		
<p><b>4.2</b></p>	<p><b>X-ray spectroscopy:</b> Principle, instrumentation, applications, advantages and limitations of X-ray absorption spectroscopy. (XAS), X-ray fluorescence spectroscopy (XRF), X-ray diffraction spectroscopy. (XRD)</p> <p><b>Mass spectrometry:</b> Instrumentation - i) Ion sources - electron impact, field ionization, field absorption, chemical ionization and fast atom bombardment sources. ii) Mass analyzers: Quadrupole, time of flight and ion trap. Applications</p> <p><b>Radio analytical Methods:</b> Neutron Activation Analysis(NAA)- Introduction, Principle, Theory and Applications. Advantages and Limitations of NAA.</p>	



Module 3	INSTRUMENTAL METHODS-III	[15L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Understand the basic concepts and applications of SEM and TEM.</li> <li>• Understand the basic concepts and applications of AAS.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Explain the basic concepts and applications of SEM, STM and TEM.</li> <li>• Explain the basic concepts, limitations, advantages and applications of AAS.</li> </ul>		
<p><b>4.3</b></p>	<p><b>Surface Analytical Techniques:</b> Principle, Instrumentation and Applications of: Scanning Electron Microscopy (SEM), Scanning Tunneling Microscopy (STM), Transmission Electron Microscopy (TEM)</p> <p><b>Atomic Spectroscopy:</b> Atomic Spectroscopy based on plasma sources – Introduction, Principle, Instrumentation and Applications. Advantages and Limitations of AAS</p>	
Module 4	ELECTROANALYTICAL METHODS	[15L]
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Get familiar with fundamental concepts and applications of Ion selective, electrodes polarography, electrogravimetry and coulometry.</li> <li>• Understand instrumentation of electrogravimetry and coulometry.</li> <li>• Understand the ion-selective electrodes and bio-catalysed membranes in polarography.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Explain the fundamental concepts and applications of Ion selective, electrodes polarography, electrogravimetry and coulometry.</li> <li>• Describe instrumentation of electrogravimetry and coulometry.</li> <li>• Describe the ion-selective electrodes and bio-catalysed membranes in polarography.</li> </ul>		



<b>4.4</b>	<p><b>Ion selective potentiometry and Polarography:</b> (Numericals are Expected)</p> <p><b>Ion selective electrodes:</b> Applications of - solid state, precipitate, liquid – liquid, enzyme, gas sensing, bio-catalytic membrane and enzyme-based biosensors electrodes.</p> <p><b>Polarography:</b> Ilkovic equation, Cottrell equation, effect of complex formation on the polarographic waves.</p> <p><b>Electrogravimetry:</b> Introduction, Principle and Instrumentation, Factors affecting the nature of the deposit. Applications.</p> <p><b>Coulometry:</b> Introduction, Principle and Instrumentation. Coulometry at controlled potential and controlled current.</p>	
<p><b>Reference Books:</b></p> <p><b>Unit I</b></p> <ol style="list-style-type: none"><li>1. Instrumental Analysis, Skoog, Holler and Crouch, 7th edition</li><li>2. HPLC Practical and Industrial Applications; E.B.Sandell and H.Onishi 2 nd Ed., CRC Press</li></ol> <p><b>Unit II</b></p> <ol style="list-style-type: none"><li>1.Essentials of Nuclear Chemistry; H J Arnikar, New Age Publishers (2005)</li><li>2.Fundamentals of Radiochemistry; D. D. Sood A. V. R. Reddy and N. Ramamoorthy, IANCAS 4th edition, 2010</li><li>3.Principles of Instrumental Analysis - Skoog, Holler and Nieman, 5th Edition, Ch: 12, 20</li></ol> <p><b>Unit III</b></p> <ol style="list-style-type: none"><li>1. Instrumental Analysis; Douglas A. Skoog - F. James Holler - Crouch, Publisher: Cengage; Edition, (2003), ISBN-10: 8131505421, ISBN-13: 978-8131505427</li><li>2. Physical Principles of Electron Microscopy, An Introduction to TEM, SEM, and AEM ; Ray F. Egerton, ISBN: 978-0- 387-25800- 3 (Print) 978-0- 387-26016- 7 (Online)</li><li>3. Modern techniques of surface science; D.P. Woodruff and T.A. Delchar, Cambridge Univ. Press, 1994.</li><li>4. Introduction to Scanning Tunneling Microscopy; C. J. Chen, Oxford University Press, New York, 1993.</li><li>5. Transmission Electron Microscopy: A text book for Material Science; David B Williams and C., Barry Carter, Springer, 2009</li><li>6. Modern Spectroscopy; J.M. Hollas, John Wiley, New York, 3rd Edition (1996),</li><li>7. Principles of Instrumental Analysis; Skoog, Holler, Nieman, Harcourt College Publishers, 5th ed., 1998.</li><li>8. Instrumental Analysis; Douglas A. Skoog - F. James Holler - Crouch, Publisher: Cengage; Edition (2003), ISBN10: 8131505421, ISBN-13: 978-8131505427</li></ol>		



#### Unit IV

1. Principles of Instrumental Analysis, Skoog, Holler, Nieman, Harcourt College Publishers, 5th Edition, 1998. Chapters - 23, 24, 25.
2. Analytical Chemistry Principles, John H Kennedy, Saunders College Publishing, 2nd edition, (1990).
3. Modern Analytical Chemistry; David Harvey; McGraw Hill Higher education publishers, (2000).
4. Vogel's Text book of quantitative chemical analysis; Pearson Education Limited, 6th edition, (2007).
5. Electrochemical Methods Fundamentals and Applications; Allen J Bard and Larry R Faulkner, John Wiley and Sons, (1980).
6. Instrumental Methods of Analysis; Willard, Merrit, Dean and Settle, CBS publishers, 7th edition

#### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√										
2.	√										
3.	√										
4.	√										
5.	√										
6.	√										
7.	√	√									
8.	√	√									
9.	√										
10.	√										



## M. Sc. (CHEMISTRY) SEMESTER II

### Elective Course-II

### COURSE TITLE: ANALYTICAL CHEMISTRY IV

### COURSE CODE: EC202 [CREDITS - 04]

#### Course Learning Outcome

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

1. Explain fundamental concepts and instrumentation of  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR Spectroscopy and determine structure of compound by spectroscopic methods.
2. Explain the working of different components of HPLC and recognize the use of different stationary and mobile phase for the separation of organic molecule in liquid chromatography
3. Define and explain the basic concept of mechanism of detection in radio analytical detectors, tracers and application of tracers in different fields.
4. Calculate the amount of radioactivity in substances using isotopic dilution, inverse isotopic dilution and neutron activation analysis methods.
5. Explain the thermal methods of analysis by TGA, the calibration of temperature scale, instrumental and experimental application.
6. Explain thermometric titration and its application.
7. Explain theory and instrumentation of NMR spectroscopy and elucidate the structure of organic compounds
8. Discuss of principle and working of HPLC with their different components.
9. Explain and apply Radio- Analytical Techniques.
10. Explain and apply the knowledge for thermal methods of analysis - TGA and TT.

#### Module 1

#### ORGANIC SPECTROSCOPY: NMR SPECTROSCOPY

[15L]

#### Learning Objectives:

This module is intended to

- Understand theory and instrumentation of NMR spectroscopy with working of various parts of instruments.
- Get familiar with structure elucidation with the help of NMR spectra.

#### Learning Outcome:

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

- Explain fundamental concepts of  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR Spectroscopy and determine structure of compound by spectroscopic methods.
- Explain instrumentation of  $^1\text{H}$  NMR Spectroscopy

#### 4.1

Theory and principles of NMR spectroscopy

#### $^1\text{H}$ NMR Spectroscopy

Proton resonance condition, Instrumentation, Aspects of PMR spectra – number of signals, chemical shift, factors influencing chemical shift,



	<p>shielding, deshielding, chemical shift values and correlation for protons bonded to carbons (aliphatic, olefinic, aldehydic, aromatic) and other nuclei (alcohols, phenols, enols, acids, amides and mercaptans), effect of deuteration, spin-spin coupling, (n+1) rule, coupling constant (J), factors effecting coupling constant “J”. structure elucidation of organic compounds with the help of UV, IR and NMR data.</p> <p><b><sup>13</sup>C NMR spectroscopy</b></p> <p>Types of <sup>13</sup>C NMR Spectra: proton coupled and decoupled <sup>13</sup>C spectra, chemical shift, calculations of chemical shifts of aliphatic, olefinic, alkyne. factors affecting chemical shifts.</p>	
<b>Module 2</b>	<b>LIQUID CHROMATOGRAPHY</b>	<b>[15L]</b>
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>Understand liquid chromatography with special focus on the instrumentation of high-pressure liquid chromatography in detail and their application in various field.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>Recognize the use of different stationary and mobile phase for the separation of organic molecule in liquid chromatography</li> <li>Explain the working of different components of HPLC.</li> <li>Identify the problems and their solution during the analysis.</li> </ul>		
<b>4.2</b>	<p>Liquid chromatography: Principle, Comparison with GC, Principle of HPLC, Instrument and significance of each component, Pumps, Guard column, Method of introducing sample, Criteria in selection of mobile phase, Stationary phases (solid, liquid), Bonded phase supports, Column used in HPLC Normal phase and Reversed phase, Isocratic and Gradient Elution Detectors: UV absorption, RI detectors</p>	
<b>Module 3</b>	<b>RADIO-ANALYTICAL TECHNIQUES</b>	<b>[15L]</b>
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>Understand the basic concepts of radio analytical techniques.</li> <li>Understand the working, detection methods of different radio analytical detectors.</li> <li>Understand the applications of radio analytical techniques in various fields.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>Define the basic concept of mechanism of detection in radioanalytical detectors.</li> <li>Explain tracers and application of tracers in different fields.</li> <li>Calculate the amount of radioactivity in substances using isotopic dilution, inverse isotopic dilution and neutron activation analysis methods.</li> </ul>		



<b>4.3</b>	<p>Radio-analytical techniques: Interaction of radiation with matter, radioactivity and units of radioactivity,</p> <p>Detection of radiation: (a) Gas Ionization detector (Ion-chamber, proportional chamber, GM-counter) (b) Scintillator detectors (Principle, organic, inorganic and plastic scintillator) (c) Solid-state detector.</p> <p>Radiochemical principle &amp; Application of tracers: (a) Reaction mechanism (example of esterification, ester hydrolysis, Friedel-Craft reaction), (b) structural determination, (c) radiometric titration (d) Isotopic dilution methods, Inverse isotopic dilution (e) Neutron activation analysis.</p>	
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<b>Module 4</b>	<b>THERMAL METHODS OF ANALYSIS THERMOGRAVIMETRY</b>	<b>[15L]</b>
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**Learning Objectives:**

This module is intended to

- Get familiar with the thermal methods, their instrumentation, effect of various factors on the experimental results and their application in various field.

**Learning Outcome:**

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

- Explain the thermal methods of analysis by TGA
- Explain the calibration of temperature scale, and instrumental and experimental application
- Explain thermometric titration and its application.

<b>4.4</b>	<p>Thermal methods of analysis thermogravimetry: Principles Thermogravimetry, Instruments for TGA- thermobalance and furnace, Calibration of temperature scale (Curie Point &amp; Melting Point), Factors affecting TGA results instrumental and experimental, Applications (Mixture, Proximate analysis, Polymer identification, Carbon black and Structure of Copper Sulfate)</p> <p>Thermometric titration: Thermometric Titration (TT), Advantages, Instrument, Applications of TT in Neutralization Titration, Precipitation Titration, Complexometric Titration and Redox Titration.</p>	
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**Reference Books:**

1. R.M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D.H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi.
3. P.Y Bruice, Organic Chemistry, 2nd Edition (1998) Prentice – Hall, New Delhi.
4. Nuclear Magnetic Resonance – Basic Principles- Atta-Ur-Rehman, Springer- Verlag (1986).
5. One and Two dimensional NMR Spectroscopy – Atta-Ur-Rehman, Elsevier (1989).



6. Organic structure Analysis- Phillip Crews, Rodriguez, Jaspars, Oxford University Press (1998).
7. Fundamental of molecular spectroscopy C.N. Banwel, J Tata Mc Graw Hill Pub. Camp.
8. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw—Hill.
9. Modern Spectroscopy, I. M. Hollas, John Wiley.
10. Essential of Nuclear Chemistry by H.J. Arnikar, New Age Interanational Publishers.
11. Basic Principles of Spectroscopy, R.Chang, McGraw-Hill.
12. Modem Methods of Chemical Analysis (2<sup>nd</sup>ed.), Pecsok, Shields, Cairns &Me Williom, John Wiley & Sons.
13. Mathematics for Chemistry, Doggett and Sucliffe, Longman.
14. Mathematical preparation for Physical Chemistry, F. Daniels, McGraw-Hill.
15. Introduction to Instrumental Analysis by R. D. Brawn, McGraw-Hill Book.
16. Fundamentals of Analytical Chemistry: Skoog D.R. and West D.M.(Holt, Rinehart &Winston, New York).
17. Quantitative Analysis, 6<sup>th</sup> Ed., R. A. Day and A.L. Underwood, Prentice-Hall of India, 1993.
18. Instrumental Analysis: G. D. Christian and J. E. O'Reilly (Allyn & Bacon Inc., NewYork, 2<sup>nd</sup> edition.
19. Instrumental Methods of Chemical Analysis: G. W. Ewing (McGraw-Hill, NewYork), 5<sup>th</sup>edition.
20. Instrumental Methods of Analysis: H. R. Willard, L. L. Merrit, J. A. Dean, F. A. Settle (Van Nostrand Reinhold Co.,New York), 6<sup>th</sup> edition.
21. Analytical Chemistry: Principles and Techniques: Larry G. Hargis (Prentice-Hall International edition).
22. Treatise on Analytical Chemistry: I. M. Kohthoff & P. J. Elving (John Wiley & Sons, New York).
23. Handbook of Analytical Chemistry: L. Meites (McGraw- Hills, NewYork).
24. Spectrometric Identification of Organic Compounds; By Robert M. Silverstein, Francis X. Webster, David J. Kiemle, David L. Bryce, 8<sup>th</sup> edition, Published by Wiley
25. Introduction to Spectroscopy; By Donald L. Pavia, Gary M. Lampman, George S. Kriz, Vyvyan, Fourth edition, Published by Brooks cole.
26. Spectroscopic Methods in Organic Chemistry; By D.H Williams, I. Fleming, Sixth edition, Published by Tata McGraw-Hill Education.
27. Spectroscopy of Organic Compounds; By P S Kalsi, Sixth edition, New Age International Publisher.
28. Organic Spectroscopy: Principles and Applications; By Jag Mohan, second edition, Published by Alpha Science International Ltd.
29. Organic Spectroscopy (NMR, IR, Mass rind UV); By Dewan S.K., First edition, CBS Publisher& Distributors Pvt Ltd.
30. Basic Principles of Spectroscopy; By Raymond Chang, Published by McGraw-Hill Inc.
31. Elementary Organic Spectroscopy; By Y R Shama, S. Chand &Company Pvt. Ltd.
32. Organic Spectroscopy: By William Kemp, Published by Palgrave Macmillan.



### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	
1.	√	√										
2.	√	√										
3.	√	√					√					
4.		√	√				√					
5.	√											
6.	√											
7.	√	√	√									
8.	√											
9.	√	√	√				√					
10.	√	√					√					



**M. Sc. (CHEMISTRY) SEMESTER II**

**Skill Enhancement Course – 2**

**COURSE TITLE: PERFUMES AND COSMETICS**

**COURSE CODE: SEC201 [CREDITS - 02]**

Course Learning Outcome		
<p>After the successful completion of the course, the learner will be able to</p> <ol style="list-style-type: none"> <li>1. Define and describe perfumes and its components</li> <li>2. Write and explain different methods of extraction for essential oils and flavors</li> <li>3. Write and explain preparation and uses of few synthetic flavors</li> <li>4. Define and discuss soaps, TFM, ingredients and additives of soaps</li> <li>5. Describe cleansing action of soaps</li> <li>6. Write and explain compositions of few important cosmetics</li> </ol>		
<b>Module 1</b>	<b>NATURAL PERFUMES, SYNTHETIC PERFUMES AND FLAVORS</b>	<b>[15L]</b>
<p><b>Learning Objectives:</b></p> <p>This module is intended to</p> <ul style="list-style-type: none"> <li>• Acquaint the students with the knowledge of different types of perfumes, its components, their extraction &amp; synthesis and composition.</li> </ul>		
<p><b>Learning Outcome:</b></p> <p>After the successful completion of the module, the learner will be able to</p> <ul style="list-style-type: none"> <li>• Define and describe perfumes and its components</li> <li>• Write and explain different methods of extraction for essential oils and flavors</li> <li>• Write and explain preparation and uses of few synthetic flavors</li> </ul>		
<p><b>5.1</b></p>	<p>Perfumes, plant and animal sources, examples, Components of perfumes, vehicle, characteristic of good vehicle, fixatives and its types, Odoriferous compounds, Extraction of essential oils by distillation, enfleurage and solvent extraction methods, Rose and Jasmine: composition and preparation of rose and Jasmine perfumes, Natural fruit concentrates as flavors: Vanilla and Cocoa. Preparation and uses of methyl anthranilate, methyl salicylate, methyl cinnamate, phenyl ethanol, citronellol, vanilline, coumarin and heliotrope.</p>	



Module 2	SOAP, SHAMPOO, COSMETICS AND PERSONAL HYGIENE PRODUCTS	[15L]
<b>Learning Objectives:</b> This module is intended to <ul style="list-style-type: none"><li>• Make students familiarize with idea of soaps, detergents and shampoos and their compositions</li><li>• Acquaint students with the knowledge of composition of few important cosmetics</li></ul>		
<b>Learning Outcome:</b> After the successful completion of the module, the learner will be able to <ul style="list-style-type: none"><li>• Define and discuss soaps, TFM, ingredients and additives of soaps</li><li>• Describe cleansing action of soaps</li><li>• Write and explain compositions of few important cosmetics</li></ul>		
5.2	Cleansing action of soaps, additives in cleansing agents, ingredient of washing and bathing soap, TFM of Bathing soap, Types of Shampoo and compositions, Characteristics of good cosmetics Evaluation of powder and basic composition of talcum powders face cream, nail polish, hair dye, toothpaste, mouthwash (Formulation only)	
<b>REFERENCE BOOKS:</b> <ol style="list-style-type: none"><li>1. Shreve's Chemical Process Industries by George T. Austin, Me Ciraw Hill India; 5th edition.</li><li>2. Perfumery technology: art, science, industry by Marcel Billot and F.V. Wells, Ellis Horwood, Ltd.; 2nd edition.</li><li>3. A textbook of cosmetic formulation by Gaurav Kumar Shamia, Jayesh Gadhiya, Meenakshi Dhanawat.</li><li>4. A handbook of cosmetics by B.M. Mithal and R.N. Saha, Delhi Vallabh Prakashan, 5th edition.</li></ol>		



### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√								
2.	√	√	√								
3.	√	√	√								
4.	√	√	√								
5.	√	√									
6.	√	√									



## M. Sc. (CHEMISTRY) SEMESTER II

### Practical Core Course-I

### COURSE TITLE: PRACTICAL INORGANIC CHEMISTRY II

### COURSE CODE: PCC201 [CREDITS - 04]

#### Course Learning Outcome

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

1. Demonstrate the analysis of alloy and ore and calculation of molarity and mole ratio.
2. Describe methods to find copper, zinc gravimetrically and volumetrically.
3. Find available chlorine in Bleaching powder.
4. Determine calcium, lead, Iron, and chromium in admixture.
5. Illustrate different methods of Preparations of inorganic salts.
6. Appreciate good laboratory practices

#### Learning Objectives

This module is intended to

- Impart basic knowledge for carrying out analysis of alloy.
- Understand the types of complexometric titrations
- Understand and calculate the percentage purity of salt.
- Determine physical constant and confirmation of product.
- Learn estimation and determination of each radical quantitatively and qualitatively.

#### CONTENTS

##### Quantitative Analysis:

1. Analysis of Solder and Type metal (Alloy Analysis)
2. Determine the amount of Ca as  $\text{CaC}_2\text{O}_4\cdot\text{H}_2\text{O}$  or as  $\text{CaCO}_3$ , in limestone
3. Estimation of  $\text{Cu}^{+2}$  as  $\text{CuSCN}$
4. Estimation of Iron in Iron ore
5. Estimation of available chlorine in bleaching powder
6. Estimation of  $\text{Ca}^{+2}$  and  $\text{Pb}^{+2}$  in Admixture
7. Determine the amount of  $\text{Fe}^{+3}$  and  $\text{Cr}^{+3}$  Present in given Admixture
8. Determine the percentage purity of the given sample of Manganese salt
9. Estimation of Aluminium by back titration.

##### References:

1. A textbook of practical inorganic chemistry - A. L. Vogel
2. Practical Chemistry by Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri
3. Advance inorganic analysis by Agarwal, Keemti lal
4. Qualitative Inorganic analysis – Vogel
5. Inorganic practical by Chatwal and Anand



### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1		√		√	√						
2				√	√						
3				√	√						
4				√	√						
5		√		√	√	√					
6				√	√						√



## M. Sc. (CHEMISTRY) SEMESTER II

### Practical Core Course-II

#### COURSE TITLE: PRACTICAL ORGANIC CHEMISTRY II

COURSE CODE: PCC202 [CREDITS - 04]

#### Course Learning Outcome

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

1. Demonstrate the basics to carry out reactions, nature of reaction and calculation of mole and mole ratio.
2. Establish mechanism and monitor a reaction at specified condition.
3. Demonstrate after the completion of reaction and purification and confirm product through the references.
4. Appreciate good laboratory practices.

#### Learning Objectives

This module is intended to

- Impart basic knowledge for carrying out preparation.
- Understand nature of reaction and establishment of reaction condition with mechanism.
- Understand calculation of mole and mole ratio for each reaction.
- Learn isolation of product from individual step and purification by crystallization.
- Determine physical constant and confirmation of product.
- Learn concept of estimation and determination of each component quantitatively.

#### CONTENTS

##### Preparation of organic compounds (Any Seven)

- a. Bromination: p-Bromoacetanilide from acetanilide
- b. Nitration : m-Dinitrobenzene from Nitrobenzene
- c. Reduction: m-Phenylenediamine from m-Dinitrobenzene
- d. Oxidation : p-Nitrobenzoic acid from p-Nitrotoluene
- e. Diazotization reaction: Orange-II
- f. Sandmeyer reaction: p-Chloro toluene from p-toluidine
- g. Friedl-Craft's reaction: Resacetophenone from Resocinol
- h. Cannizzaro reaction: Benzoic acid from Benzaldehyde via KOH
- i. Aldol condensation: Chalcone from Benzaldehyde + Acetophenone  
(Claisen Schmidt reaction)



### Quantitative Estimations (Any Three)

- Estimation of ester + acid
- Estimation of amide + acid
- Estimation of formaldehyde via oxime
- Estimation of number of carboxylic acid (succinic acid, oxalic acid)

### References:

- A text book of practical organic chemistry – A. I. Vogel
- Practical organic Chemistry – Mann and Saunders
- A handbook of quantitative and qualitative analysis – H. T. Clarke
- Comprehensive Practical Organic Chemistry : Qualitative Analysis V K Ahluwalia & S. Dhingra.
- Comprehensive Practical Organic Chemistry : Preparations and Quantitative Analysis V K Ahluwalia & R. Aggarwal Universities Press.
- An Advance Course in practical Chemistry, A K. Nad, B. Mahapatra and A. Ghoshal.

### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1			√	√	√	√	√				
2			√	√	√	√	√				
3			√	√	√	√	√				
4			√	√	√	√	√				
5			√	√	√	√	√				



## M. Sc. (CHEMISTRY) SEMESTER II

### Practical Core Course-III

#### COURSE TITLE: PRACTICAL PHYSICAL CHEMISTRY III

#### COURSE CODE: PCC203 [CREDITS - 04]

#### Course Learning Outcome

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

1. Utilize knowledge of preparation of solutions
2. Inspect the rate of reactions in chemical kinetics.
3. Demonstrate the use of pH-meter, potentiometer, conductivity bridge and colorimeter
4. Describe partitioning behavior of compound.
5. Determine the solubility and solubility product of sparingly soluble salts.

#### Learning Objectives

This module is intended to

- Study the physical chemistry parameters for reaction between acid and base.
- Study rate of reaction by conductometry.
- Determine the concentration of solution by colorimetry
- Understand the conductivity behaviour of electrolytic solutions.
- Learn partitioning behaviour of component in two phases

#### CONTENTS

- Determine the dissociation constant and strength of borax solution pH-metrically.
- Determine the velocity constant of the hydrolysis of ethyl acetate with sodium hydroxide at room temperature by conductance measurements.
- Determine the solubility of silver chloride in water potentiometrically.
- To determine the concentration of given components in a mixture colorimetrically.
- Determine the equilibrium constant of the reaction  $I^- + I_2 = I_3^-$  by distribution method.
- Investigation the reaction between  $H_2O_2$  and  $HI$  at two different temperatures and calculate the energy of activation for the reaction
- Determine the formula of a complex between  $Cu^{+2}$  and  $NH_3$  by distribution method.
- Determine the CMC of a surfactant at room temperature and thermodynamic parameters using conductivity measurements.
- Determination of CMC and area per molecule of a surfactant by surface tension measurement.

Note: Students require minimum seven experiments to be performed.



### References:

1. Advanced Practical Physical Chemistry by Yadav J. B., Krishna Prakashan Media
2. Practical Physical Chemistry, Dr. M. Satish Kumar Sankalp Publication
3. Gurtu, J. N., Kapoor, R., Advanced Experimental Chemistry S. Chand & Co. Ltd.
4. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson

### Mapping of CLOs and PSOs

Course Learning Outcomes	Programme Specific Outcomes										
	1	2	3	4	5	6	7	8	9	10	11
1.	√	√	√			√					
2.	√	√	√			√	√				
3.	√	√	√	√	√	√	√				
4.	√	√	√			√	√				
5.	√	√	√			√	√				