Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science, Commerce, Baramati

(Autonomous)

DEPARTMENT OF CHEMISTRY

(Faculty of Science and Technology)

Two Year M.Sc. Degree Program Chemistry

M.Sc. II Inorganic Chemistry

(NEP Pattern)

Choice Based Credit System Structure and Syllabus

(To be implemented from June 2024)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Chemistry and related subjects, the Board of Studies in Chemistry at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of M.Sc. Part-II Chemistry, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

A chemistry degree equips students with the knowledge and skills necessary for a diverse range of fulfilling career paths. Graduates in chemistry find opportunities in various fields, including This includes industries like glass, cement, paper, textile, leather, dye, etc. We

also see huge chemistry applications in industries like paints, pigments, petroleum, sugar, plastics, and Pharmaceuticals.

Overall, revising the chemistry syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing healthcare needs.

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati.

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati is an autonomous & dynamic institute and has successfully implemented the National Education Policy-2020 since the academic year 2023-24. We are updating our academic policies as per local needs keeping in view the global perspectives. Accordingly, we have updated our program outcomes as per the graduate attributes defined in New Education Policy.

Program Outcomes for M.Sc.

1. Comprehensive Knowledge and Understanding:

Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.

2. Practical, Professional, and Procedural Knowledge:

Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios.

3. Entrepreneurial Mindset, Innovation, and Business Understanding:

Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.

4. Specialized Skills, Critical Thinking, and Problem-Solving:

Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.

5. Research, Analytical Reasoning, and Ethical Conduct:

Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.

6. Communication, Collaboration, and Leadership:

Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.

7. Digital Proficiency and Technological Skills:

Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.

8. Multicultural Competence, Inclusive Spirit, and Empathy:

Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.

9. Value Inculcation, Environmental Awareness, and Ethical Practices:

Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.

10. Autonomy, Responsibility, and Accountability:

Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

List of Members Present for the BOS Meeting

The following internal and external BOS members were attended the Board of Studies

Sr. No.	Name of Member	Designation
1.	**Dr. Sanjay R. Kale** Head & Professor, Department of Chemistry, T. C. College, Baramati.	Chairman
2.	**Dr. Namdeo N. Bhujbal** Professor, Department of Chemistry Magar College, Hadapsar, Pune	External Member VC Nominee.
3.	**Dr. D. M. Pore** Professor, Department of Chemistry Shivaji University, Kolhapur	External Member from other University
4.	**Dr.Shrikrushna T. Salunke** Associate Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
5.	**Mr. Bhimrao R. Torane** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
6.	**Mr. Maharudra A. Dudhe** Assistant Professor, Department of Chemistry, T. C. College, Baramati	Internal Member
7.	**Mr. Ravikiranamrut R. Gandhi** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
8.	**Dr. Vaibhav P. Landage** Associate Professor, Department of Chemistry T. C. College, Baramati	Internal Member
9.	**Dr. Yogesh N. Indulkar** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
10.	**Dr. Rahul S. Bhondwe.** Assistant Professor, Department of Chemistry T. C. College, Baramati	Internal Member
11.	**Dr. Nilam C. Dige** Assistant Professor, Department of Chemistry T. C. College, Baramati.	Internal Member

12.	**Mrs. Supriya S. Deokate** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
13.	**Mrs. Jyoti T. Waghmode** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
14.	**Ms. Geetanjali S. Bhunje** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
15.	**Mrs. Reshma T. Gadadare** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
16.	**Mrs. Swati A. Deokate** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
17.	**Mrs. Gaytri D. Pirale** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
18.	**Mrs. Sonali P. Nale** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
19.	**Ms. Farhin H. Shaikh** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
20.	**Ms. Anjali N. Bhong** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
21.	**Mr. Harshad J. Salunkhe** Assistant Professor, Department of Chemistry, T. C. College, Baramati.	Internal Member
22.	**Mr. Saurabh Pandhare** T. C. College, Baramati	PG Student
23.	**Mr. Niranjan Ghuge** T. C. College, Baramati	UG Student
24.	**Mr. Vijay Gorave** T. C. College, Baramati	UG Student

Course Structure for (M.Sc. Inorganic Chemistry) Part-II (NEP Pattern)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	No. of Credits
III	Major (Mandatory)	CHI-601-MJM	Inorganic reaction mechanism and organometallic chemistry	Theory	04
	Major (Mandatory)	CHI-602-MJM	Nanomaterials and physical methods in Inorganic Chemistry	Theory	04
	Major (Mandatory)	CHI-603-MJM	Analysis, Estimation and computer application	Practical	02
	Major (Mandatory)	CHI-604-MJM	Inorganic Preparations and instrumental analysis	Practical	02
	Major (Elective)	CHI-611-MJE (A)	Bioinorganic and Inorganic medicinal chemistry OR	Theory	02
		CHI-611-MJE (B)	Advance topics in Inorganic Chemistry-II		
	Major (Elective)	CHI-612-MJE (A)	Inorganic Chemistry practical I OR	Practical	02
		CHI-612-MJE (B)	Inorganic chemistry Practical II		
	Research Project (RP)	CHI-621-RP	Research Project (RP)	Practical	04
			Total Credits Semester III		**20**
IV	Major (Mandatory)	CHI-651-MJM	Homogeneous and heterogeneous catalysis	Theory	04
	Major (Mandatory)	CHI-652-MJM	Material Science -I Solid state chemistry	Theory	04
	Major (Mandatory)	CHI-654-MJM	Extended Practicals in Inorganic Chemistry I	Practical	02
	Major (Elective)	CHI-661-MJE (A)	Industrial applications in Inorganic chemistry OR	Theory	02
		CHI-661-MJE (B)	Environmental Chemistry		

	Major (Elective)	CHI-662-MJE (A)	Inorganic chemistry Practical III OR	Practical	02
		CHI-662-MJE (B)	Inorganic chemistry Practical IV		
	On Job Training (OJT)/Field Project (FP)	CHI-681-RP	Research Project (RP)	Training/ Project	06
	Total Credits Semester II				**20**
	Cumulative Credits of Semester I and II				**40**

CBCS Syllabus as per NEP 2020 for M.Sc. II Inorganic chemistry (NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Mandatory Theory
Course Name	**:** Inorganic reaction mechanism and Organometallic Chemistry
Course Code	**:** CHI-601-MJM
No. of Lectures	**:** 60 (48+12T)
No. of Credits	**:** 4 credits

Course Objectives:

- To understand basic principle and applications of organometallic chemistry
- Students will be able to learn metal-metal bonds, clusters, cadges, fluxional behavior.
- Students will be able to synthesis of carbene, carbynes, sigma and pi complexes.
- Students will be able to learn about C-C coupling reactions, applications.
- Student should able to understand different types of inorganic reactions.
- Student should able to differentiate between SN^1 and SN^2 reaction mechanism.
- Student should able to understand substitution reactions in square planer and octahedral complexes
- Student should be able to understand different types of photochemical reactions
- Student should be able to understand magnetic properties of compound
- Student should able to understand Student inorganic reaction mechanism

Course Outcomes:

CO1: get knowledge about Synthesis, bonding, & applications of sigma & Pi complexes as Well as Carbene& Carbynes.

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture.

CO4: get knowledge about stability, lability, chelates effect, HSAB principle.

CO5: To understand about substitution reactions in square planar & octahedral complexes.

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

CO7: To get knowledge about reactions of co-ordinate ligands.

CO8: student think critically to find the application of magnetic materials.

Topics and Learning Points

Unit 1: **(8L)**

Types of Mechanisms: Basic concepts as stability and lability, stability constants; HSAB principle, Chelate effect, Macrocyclic effect; ligand transfer and electron transfer reaction in coordination compounds, intimate and stoichiometric mechanism of ligand substitution, Substitution in square planar complexes- trans effect, trans series, applications of trans effect

Unit 2: **(8L)**

Substitution in octahedral complexes- SN^1, SN^2, SN^1CB mechanisms, Racemization in coordination compounds, steric effects on substitution Electron transfer reactions-Potential energy diagrams as a conceptual tool, Marcus equation, types of electron transfer reactions and factors affecting on electron transfer reactions.

Unit 3: **(8L)**

Photochemical reactions- Prompt and Delayed reactions, Quantum yield, Recapitulation of fluorescence and Phosphorescence, Photochemical reactions by Irradiating at d-d and charge transfer bands,Transitions in metal-metal bonded systems, photochemical reactions involving chlorophyll, Kinetics of excited state

Unit 4: **(8L)**

Magnetic moments based on crystal field ground term, perturbation theory and its applications, anomalous magnetic moments in magnetically dilute and concentrated system in various symmetrical environments of coordination complexes, Mixed valence compounds

Unit 5: **(6L)**

nCnRn: Carbocyclic Polyenes: Synthesis, bonding, properties and applications Allyls, Pentadienyls, Cyclobutadienes, Cyclopentadienyl, Cycloheptatrienyls, Arenes, Cyclooctatetraenes.

Unit 6: **(10L)**

Fluxional Behaviour of organometallic compounds and study of organometallic compound by NMR, IR. Phosphine complexes: Synthesis, bonding, properties, and applications.
Roll of transition metal organometallics in organic synthesis: As electrophiles and nucleophiles, Activating agents and protecting agents agriculture and horticulture.

References:

1. Basic inorganic Chemistry by F.A. cotton and G. Wilkinson, Wiley Eastern limited new Delhi.
2. Inorganic Chemistry by D. F. Shriver and P.W. Atkins
3. Mechanisms of Inorganic reactions by C.F. Basolo and R.G. Pearson Wiley New York.
4. Magneto chemistry by Shamal and Dutta.
5. Organometallics: A concise Introduction, Ch. Elshebroicn and A. Salzer, VCH, chapters 12-16
6. Inorganic Chemistry 3rd edn. D.F. Shriver and P.W. Atkins, Oxford University Press, 1999, Chapter 16.
7. Inorganic Chemistry- Principles of structure and reactivity, J.E. Huheey, E.A. Keiter and R.L. Keiter 4th Edn. Harper Collins publication New York.
8. Mechanism of Inorganic Reactions in solution-an introduction, D. Benson, Mc Graw-Hill publication
9. Organometallic Chemistry –R.C. Mehrotra and A. Singh, 1992, Wiley
10. Principles of Organometallic Chemistry, P. Powell, Chapman & Hall
11. Organometallic Compounds, Morries, Sijlirn, IVY Publication House
12. Organometallic Chemistry-E.J. Elias and Gupta

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Inorganic reaction mechanism and Organometallic chemistry **Course Code**: CHI-601-MJM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	0	0	0	0	0	0	0	0
CO2	3	3	3	2	2	0	2	0	0	0
CO3	3	0	2	2	2	0	2	0	0	0
CO4	3	3	0	0	0	0	0	0	0	0
CO5	3	0	0	0	0	0	0	0	0	0
CO6	3	3	2	2	2	0	0	0	0	0
CO7	3	0	0	2	0	0	0	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: get knowledge about Synthesis, bonding, & applications of sigma & Pi complexes as Well as Carbene& Carbynes.

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture.

CO4: get knowledge about stability, lability, chelates effect, HSAB principle.

CO5: To understand about substitution reactions in square planar & octahedral complexes.

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

CO7: student think critically to find the application of magnetic materials.

PO2: Practical, Professional and Procedural knowledge

CO1: get knowledge about Synthesis, bonding, & applications of sigma & Pi complexes as Well as Carbene& Carbynes.

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture &

horticulture.

CO4: get knowledge about stability, lability, chelates effect, HSAB principle

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture.

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

CO7: student think critically to find the application of magnetic materials.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture.

CO6: know applications about detail concepts in photochemical reactions like prompt, delayed, Quantum effect, Luminescence.

PO7: Digital Proficiency and Technological skills

CO2: able to apply research skills in OMC in pharmaceuticals, medical, agriculture & horticulture.

CO3: understand Applications of OMC in pharmaceuticals, medical, agriculture & horticulture.

CBCS Syllabus as per NEP 2020 for M.Sc. II
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Mandatory Theory
Course Name	**:** Nanomaterial and Physical methods in Inorganic Chemistry
Course Code	**:** CHI-602-MJM
No. of Lectures	**:** 60 (48+12T)
No. of Credits	**:** 4 credits

Course Objectives:

- Students should be able to understand principle, instrumentation of various techniques.
- Students should be able to handle various instruments and applied for characterization of various compounds.
- Student should be able to understand ESR, XRD, XPS, Mossbauer spectroscopy.
- Students will be able to identify and describe different approaches used in the treatment
- Student will learn principle of different technique.
- Student will understand basic concepts, principle and applications.
- Student should be able to analyse ESR, XPS XRD, Mossbauer spectra.
- Student should be able to determine magnetic nature, crystalline size & structures.
- understand properties of nanomaterials and their structural determination by using instrumental techniques.

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: Demonstrate Comprehensive knowledge of nanomaterials including their characterization, properties and applications in various fields

CO2: To understand Principle, Instrumentation & applications of thermal techniques.

CO3: Apply critical thinking skills to evaluate and interpret experimental sata related to nanomaterials and physical methods.

CO4: Develop an understanding of business concepts related to the production,marketing and

regulation of any compounds and nanomaterial-based products

CO5: Collaborate effectively with peers and professionals from divesr backgrounds to solve complex problems

CO6: Inculcate values of ethical practices in research, including integrity, honesty, transparency in experimental procedures and data reporting

CO7: Student finds the applications of instrumental technique in various field like biology, physics, microbiology etc.

Topics and Learning Points

Principles, Instrumentation & Applications of the following techniques,

Unit 1: Electron Spin resonance Spectroscopy,

Thermal technique (DTA, DSC, DMA) (8L)

Unit 2: X-Ray Diffraction Powder & Single Crystal **(**8L)

Unit 3: Cyclic Voltammetry and Mossbauer spectroscopy (8L)

Unit 4: Structural determination, application, morphology: SEM, TEM, HRTEM, FESEM, Cryo-SEM, (8L)

Unit 5: Raman spectroscopy, AFM, STM. XPS (8L)

Unit 6: Nano porous materials and Applications of nanotechnology in medicinal chemistry, Biological Applications & sensor. (8L)

References:

1) Structural methods in Inorganic Chemistry–E.A.V.Edsworth, D.W.H.Rankin & S. Cradock, Blackwell Scientific Publication, 1987.
2) Physical Methods for Chemists-R.S.Drago,(2ndedition, Saunders)
3) Instrumental methods of Chemical Analysis–Chatwal & Anand
4) Laboratory Techniques in Electroanalytical Chemistry edited by P. T. Kissinger and W. R. Heinman (1984) M. Dekker vinc (USA)
5) The Chemistry of Nanomaterials edited by C.N.R.Rao, A. Muller, A. K. Cheetham
6) Wiley-VCH Verlag GmbH & co. Volumes 1&2
7) WTEC Panel Report on Nanostructure Science and Technology edited by Richard
8) Siegel, Evelin Hu7M.C. RoCo—Kluwer Academic Publishers, Boston/London.
9) Nanomaterials by Dr. Sulbha Kulkarni.
10) Nanotechnology, G. Timp; Springer, AIP Press, 2012.
11) Nanoscopic Materials – Size Dependent Phenomenon, E. Roduner, RSC Publishing 2006.
12) Nanochemistry – A Chemical Approach to Nanomaterials, G. A. Ozim, A. C.
    i. Arsenault, L. Cadematiri, RSC Publishing 2009.

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Nanomaterial and Physical methods in Inorganic Chemistry **Course Code**: CHI-602-MJM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	0	0	2	0	0	0	0	0
CO2	3	2	2	0	3	0	2	0	0	0
CO3	0	0	3	2	0	0	0	0	0	0
CO4	0	0	3	0	0	3	3	3	3	0
CO5	0	0	0	1	3	3	3	2	3	2
CO6	0	0	0	0	2	0	0	0	2	3
CO7	0	0	0	3	2	0	0	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Demonstrate Comprehensive knowledge of nanomaterials including their characterization, properties and applications in various fields

CO2: To understand Principle, Instrumentation & applications of thermal techniques.

PO2: Practical, Professional and Procedural knowledge

CO1: Demonstrate Comprehensive knowledge of nanomaterials including their characterization, properties and applications in various fields

CO2: To understand Principle, Instrumentation & applications of thermal techniques

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO2: To understand Principle, Instrumentation & applications of thermal techniques.

CO3: Apply critical thinking skills to evaluate and interpret experimental data related to nanomaterials and physical methods.

CO4: Develop an understanding of business concepts related to the production, marketing and regulation of any compounds and nanomaterial-based products

PO4: Specialized Skills, Critical thinking and Problem solving

CO3: Apply critical thinking skills to evaluate and interpret experimental data related to nanomaterials and physical methods.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems

CO7: Student finds the applications of instrumental technique in various field like biology, physics, microbiology etc.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: Demonstrate Comprehensive knowledge of nanomaterials including their characterization, properties and applications in various fields

CO2: To understand Principle, Instrumentation & applications of thermal techniques.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems

CO6: Inculcate values of ethical practices in research, including integrity, honesty, transparency in experimental procedures and data reporting

CO7: Student finds the applications of instrumental technique in various field like biology, physics, microbiology etc.

PO6: Communication, Collaboration and Leadership

CO4: Develop an understanding of business concepts related to the production, marketing and regulation of any compounds and nanomaterial-based products.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems.

PO7: Digital Proficiency and Technological skills

CO2: To understand Principle, Instrumentation & applications of thermal techniques.

CO4: Develop an understanding of business concepts related to the production, marketing and regulation of any compounds and nanomaterial-based products.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems.

CO7: Student finds the applications of instrumental technique in various field like biology, physics, microbiology etc.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO4: Develop an understanding of business concepts related to the production, marketing and regulation of any compounds and nanomaterial-based products.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems.

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO4: Develop an understanding of business concepts related to the production, marketing and regulation of any compounds and nanomaterial-based products.

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems.

CO6: Inculcate values of ethical practices in research, including integrity, honesty, transparency in experimental procedures and data reporting

PO10: Autonomy, Responsibility and Accountability

CO5: Collaborate effectively with peers and professionals from diverse backgrounds to solve complex problems.

CO6: Inculcate values of ethical practices in research, including integrity, honesty, transparency in experimental procedures and data reporting

CBCS Syllabus as per NEP 2020 for M.Sc. II (NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Mandatory Practical
Course Name	**:** Analysis, Estimation and computer applications
Course Code	**:** CHI-603-MJM
No. of Lectures	**:** 60 (48+12T)
No. of Credits	**:** 4 credits

Course Objectives:

- Student should be able to select method for analysis, decide and prepare for analysis.
- Students should able to select procedure for analysis, identify sources possible errors in the result obtained.
- Students should able to introduce methods of chemical analysis.
- Perform required calculations involved in the analysis by titrametrically as well as gravimetrically.
- Students should able to know various instrumental methods of analysis.
- Students will get an opportunity to handle and understand principles of different instruments.
- Exercise their critical thinking in creating new knowledge.
- Effectively communicate the knowledge of their study and research in their respective disciplines

Course Outcomes:

After successfully completing this course students will know,

CO1: To understand methods of alloy analysis & ore analysis.

CO2: Student able to apply their knowledge to select method of analysis.

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO4: To inculcate honestly and integrity under students.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

Topics and Learning Points

A. Alloy analysis (any2)

1. To determine the amount and percentage of Ni, Fe, Cr from Nichrome alloy
2. To determine the amount and percentage of Cu, Ni, Fe from Monel metal
3. To determine the amount and percentage of Cu, Sn, Zn from Gun metal

B. Ore analysis (any2)

1. To determine amount and percentage of Fe, Ti, Al and silica from Illemenite ore
2. To determine amount and percentage of Ca, Mg, Si from Dolomite ore
3. To determine amount and percentage of Fe, Si, Ca from cement sample

C. Instrumental analysis (any1)

1 To determine Zn/Cu/Fe/Mn from soil sample by AAS method
2. Flame photometric estimation of each Na,K from given sample by working curve method
3. Determination of Assay of Metformin by UV
4. Determination of nitrogen by using nitrogen analyser from given sample.

D. Inorganic Estimations (any4)

1. Estimation of Mn from tea leaves.
2. Estimation of Vitamin C from lemon juice.
3. Estimation of Cu from fungicide.
4. Estimation of calcium and silica from ash.
5. Determination of Chromium from zinc chrome.
6. Determination of Fe and Zn from Iron and Zinc supplementary capsule.
7. Determination of amount and percentage of caffeine from coffee.
8. Estimation of Calcium/ Magnesium by complexometric titration in Face powder
9. Determination of amount and percentage of titanium and silica in tooth powder.

E. Ion exchange chromatography (any 1)

1 Separation and estimation of mixture of Zn(II) and Mg(II)
2 Separation and estimation of mixture of Al(III) and Mg(II)

F. Report on Industrial Visit

(Note: Minimum 10 experiments should be completed in this course.)

References:

1. A textbook of qualitative inorganic analysis: A. I. Vogel
2. Inorganic synthesis– King
3. Synthetic inorganic chemistry: W.L.Jolly
4. Experimental Inorganic chemistry by W.G.Palmer
5. The analysis of minerals and ores of rare elements: W.R.Schoeller, A.R.Powell, Charles, Griffin and company limited.

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Analysis, Estimation and computer applications **Course Code**: CHI-603-MJM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	0	2	0	0	0	0	0
CO2	3	2	0	2	0	0	0	0	0	0
CO3	2	3	3	0	3	2	0	3	3	0
CO4	3	0	0	3	0	3	0	3	3	3
CO5	3	3	2	3	3	0	0	0	0	0
CO6	2	0	0	2	0	0	3	0	0	0
CO7	2	3	3	2	2	0	0	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: To understand methods of alloy analysis & ore analysis.

CO2: Student able apply to their knowledge to select method of analysis.

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO4: To inculcate honestly and integrity under students.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

PO2: Practical, Professional and Procedural knowledge

CO1: To understand methods of alloy analysis & ore analysis.

CO2: Student able to apply their knowledge to select method of analysis.

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: To understand methods of alloy analysis & ore analysis.

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

PO4: Specialized Skills, Critical thinking and Problem solving.

CO2: Student able to their knowledge to select method of analysis.

CO4: To inculcate honestly and integrity under students.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: To understand methods of alloy analysis & ore analysis.

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO5: Separations and estimation of mixture by using ion exchange chromatography.

CO7: think critically to find correct method to estimate amount of metals from unknown samples.

PO6: Communication, Collaboration and Leadership

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO4: To inculcate honestly and integrity under students.

PO7: Digital Proficiency and Technological skills

CO6: Student will get opportunities to handle and understand principles of different instruments

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO4: To inculcate honestly and integrity under students.

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO3: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO4: To inculcate honestly and integrity under students.

PO10: Autonomy, Responsibility and Accountability

CO4: To inculcate honestly and integrity under students.

CBCS Syllabus as per NEP 2020 for M.Sc. II chemistry
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Practical
Course Name	**:** Inorganic Preparations & Instrumental Analysis
Course Code	**:** CHI-604-MJM
No. of Lectures	**:** 30 (24+6T)
No. of Credits	**:** 2 credits

Course Objectives:

- Students should able to know various instrumental methods of analysis.
- Students should able to introduce methods of chemical analysis.
- Student should be able to knowledge about magnetic succeptibility, TGA, CV aquation etc.
- Student should able to know the various instrumental methods of analysis.
- should be able to understand magnetic properties of compound
- student will get knowledge about instrumental methods and analysis of compound.

Course Outcomes:

CO1: To understand magnetic properties of compound

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate complence and reliability in students.

Topics and Learning Point

A. Inorganic preparations (any4)

1. Preparation of dichloro (triphenyl phosphine) nickel (II) sulphate
2. Preparation of potassium hexa thio cyanato chromate (III)
3. Preparation of trans-dichlorobis-ethylenediamine cobalt (III) chloride
4. Preparation of tris (acetyl acetonato) Aluminum (III) Sulphate.
5. Preparation of chloro aquo tetrammine cobalt sulphate
6. Preparation of chrome alum
7. Preparation of Cu (o-phen)$_2$
8. Preparation of potassium dihydroxo dioxalato titanate(IV) and estimation of titania

B. Preparation of solid- state material (any3)

1. Nickel ferrite
2. zinc ferrite
3. $BaZrO_3$
4. MnO_2
5. Nickel oxide
6. TiO_2

C. Instrumentation (any3)

1. Magnetic susceptibility of Co-ordination complexes by Gauy's method to determine number of unpaired electrons from given complex.
2. Thermogravimetric analysis
3. TGA for analysis of $CuSO_4$ and NaCl find out the percentage of each constituent in mixture.
4. To determine the number of water molecules in each hydrated complex using thermo gravimetric analysis
5. Photocatalytic degradation of dye using ZnO/TiO_2 nanoparticles (synthesis by Sol-gel method)
6. To determine amount of chloride/Sulphate/Phosphate from given sample solution by turbidometric titration
7. Cyclic Voltametric study of Fe(II)/Fe(III) system.Basic principle and calculation of basic parameters from CV.

D. Chemical Kinetics (Any2)

1. To study rate of aquation of tris1-10phenanthrolein Fe(II) in acid solution by spectrophotometer.
2. To study rate of aquation of trans dichloro bisethylenediammine cobalt (III) chloride
3. To determine corrosion rate of metal strips (mild steel or aluminum) in different concentration of acidic or alkali medium
4. To study the effect of 1,10 phenanthroline on corrosion inhibition of mild steel in H_2SO_4

E. Table Work: Spectral interpretation of some solid crystalline substances by XRD, NMR, FTIR (2 spectra each)

(Note: Minimum 10 experiments should be Completed in this Course)

References:

1. A textbook of qualitative inorganic analysis: A. I. Vogel
2. Inorganic synthesis– King
3. Synthetic inorganic chemistry: W.L.Jolly
4. Experimental Inorganic chemistry by W.G.Palmer
5. The analysis of minerals and ores of rare elements:W.R. Schoeller,A.R. Powell, Charles, Griffin and company limited

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Inorganic Preparations and instrumental analysis **Course Code**: CHI-604-MJM
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	0	0	0	0	0	0	0	0
CO2	3	2	0	2	0	2	3	2	0	3
CO3	2	2	3	3	3	2	3	3	3	3
CO4	3	3	0	3	3	3	3	1	0	0
CO5	2	0	0	0	0	3	3	2	0	0
CO6	3	3	2	0	0	0	2	0	0	2
CO7	3	3	3	0	0	0	0	0	3	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: To understand magnetic properties of compound

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate compliance and reliability in students.

PO2: Practical, Professional and Procedural knowledge

CO1: To understand magnetic properties of compound

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments,

identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate complence and reliability in students.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate compliance and reliability in students.

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

PO5: Research, Analytical Reasoning and Ethical Conduct

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

PO6: Communication, Collaboration and Leadership

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

PO7: Digital Proficiency and Technological skills

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum & apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

CO6: To understand method of analysis of sample by different technique.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO2: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO7: To inculcate complence and reliability in students.

PO10: Autonomy, Responsibility and Accountability

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO6: To understand method of analysis of sample by different technique.

CBCS Syllabus as per NEP 2020 for M.Sc. II
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**: Elective Theory**
Course Name	**:** Bioinorganic and Inorganic medicinal Chemistry
Course Code	**:** CHI-611-MJE (A)
No. of Lectures	**:** 30 (24+6T)
No. of Credits	**:** 2 credits

Course Objectives:

- Students will able to recognize and explain the interaction of different metal ions with biological ligands
- To understand various functions and biochemistry of enzyme containing metals.
- To Understand the concept & to find out biological role
- Students will able to understand inorganic metals in biology
- Student should explain the functions of haemoglobin & myoglobin
- Students should able to understand role of various metals in medicine
- Students should able to understand Antitumour, anti-HIV , anti-anthritic activity
- Student should able to understand the mechanism about medicinal chemistry.

Course Outcomes:

After successfully completing this course, students will be able to:

CO1: get knowledge about role of metals in Biology.

CO2: To study the function & biochemistry of Zinc, nickel, Molybdenum, Copper & Manganese.

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO5: To know about metalloproteins as a drug target.

CO6: To study about metal based chemotherapeutic drugs as well as diagnostic agents.

CO7: Students analyze the biological functions of metals in human body.

Topics and Learning Points

Unit 1: **(12L)**

Recapitulation of biological roles of metals and ligand structure, function and biochemistry of enzymes containing

1. **Zinc**: Zinc finger, carboxy peptidase, carbonic anhydrase,
2. **Nickel**: Niinproteins, Nickel transport and enzyme active site assembly, coordination of biological nickel.
3. **Molybdenum**: Cofactors, antagonism between copper and molybdenum hydroxylase
4. **Copper**: non-blue cop per proteins
5. Manganese
6. Biochemistry of chromium and vanadium
   Radio pharmaceuticals and MRI contrast agents.

Unit 2: **(4L)**

Cis-platin based anticancer agents: Mode of action, mechanism.

Biomedical uses of lithium : Chemistry of lithium, Distribution in the body And cells, Biochemistry of lithium and lithium isotope.

Unit 3: **(4L)**

Bismuth in medicine: Chemistry of bismuth Bismuth in medicine-helicobacter, pylori bacterium methods for the study of bismuth, Bismuth citrate complex Bismuth complexes with biomolecules- bismuth binding to oxygen containing biomolecules, bismuth complexes with thiolate ligands, bismuth (III) complexes with metallothionine and transferring, enzyme inhibition

Unit 4 : **(4L)**

Gold complexes with anti-arthritic, anti-tumour and anti-HIV activity : Introduction, chrysotherapy, history medicinal uses Gold chemistry-Oxidation state, Gold (I) complexes, Gold(III) complexes, oxidation-Reduction potentials **,**Gold biochemistry and pharmacology-invivo Metabolism and ligand displacement, antitumor, anti-HIV activity.

References:

1. Bioinorganic chemistry- R. J. P. Williams
2. Bioinorganic chemistry :An Introduction, Robert Crichton, Elsevier Science, 2007.
3. Metal complexes as enzyme Inhibitors A.Y.Louiwe and Thomas Meade Chem.Rev. 1999,99,2711
4. Bioinorganic chemistry: Inorganic elements in the chemistry of life, An introduction and guide- wolfgang Kaim, Brigille Schwedrski, John Wiley and sons 1994.
5. Principle of Bioinorganic chemistry-S.J.lippard and J.M.Berg,University science Books 1994.
6. The Biological Chemistry of the elements: The Inorganic Chemistry of life- Silva, J.J.R.Fraustoda and R.J.P.Williams second E.d.oxford university press, 2012.
7. Uses of inorganic chemistry in medicine Ed. Nicholas,P. Farrel

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Bioinorganic and Inorganic medicinal chemistry **Course Code**: CHI-611-MJE (A)
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	0	0	0	0	0	0	0
CO2	3	3	0	0	0	0	0	0	0	0
CO3	3	3	0	0	3	2	3	0	0	2
CO4	3	3	3	0	2	3	3	0	0	2
CO5	3	2	0	0	2	0	0	0	0	0
CO6	0	0	2	2	2	0	2	0	0	0
CO7	0	3	0	2	2	0	2	0	0	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: get knowledge about role of metals in Biology.

CO2: To study the function & biochemistry of Zinc, nickel, Molybdenum, Copper & Manganese.

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO5: To know about metalloproteins as a drug target.

PO2: Practical, Professional and Procedural knowledge

CO1: get knowledge about role of metals in Biology.

CO2: To study the function & biochemistry of Zinc, nickel, Molybdenum, Copper & Manganese.

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO5: To know about metalloproteins as a drug target.

CO7: Students analyze the biological functions of metals in human body.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: get knowledge about role of metals in Biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO6: To study about metal based chemotherapeutic drugs as well as diagnostic agents.

PO4: Specialized Skills, Critical thinking and Problem solving

CO6: To study about metal based chemotherapeutic drugs as well as diagnostic agents.

CO7: Students analyze the biological functions of metals in human body.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO6: To study about metal based chemotherapeutic drugs as well as diagnostic agents.

CO7: Students analyze the biological functions of metals in human body.

PO6: Communication, Collaboration and Leadership

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

PO7: Digital Proficiency and Technological skills

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO6: To study about metal based chemotherapeutic drugs as well as diagnostic agents.

CO7: Students analyze the biological functions of metals in human body.

PO10: Autonomy, Responsibility and Accountability

CO3: get knowledge about Radiopharmaceuticals & their applications in biology.

CO4: get knowledge about application of inorganic elements in medicinal field.

CO7: Students analyze the biological functions of metals in human body.

CBCS Syllabus as per NEP 2020 for M.Sc. II (NEP Pattern)

Name of the Programme : M.Sc. Inorganic Chemistry
Program Code : CHE
Class : M.Sc. II
Semester : III
Course Type : Elective Theory
Course Name : Advanced topics in Inorganic Chemistry
Course Code : CHI-611-MJE (B)
No. of Lectures : 30 (24+6T)
No. of Credits : 2 credits

Course Objectives:

- Student can able to understand types reactions of coordinated ligand
- Student can apply their knowledge to identify chelate forming ligands
- Student can find reactions of inorganic polymers
- Student can understand the difference between organic and inorganic polymers.
- Student can understand the concept of photocatalysis.
- Students can define terms of coordination chemistry
- Student critically evaluate the challenges of photocatalysis.

Course Outcomes:

CO1: Students understand descriptive chemistry of inorganic polymer.

CO2: Student will be able to classify inorganic polymers.

CO3: Students can define various types of chemical bonds

CO4: Students investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

Topics and Learning Points

Unit 1: Reactions of coordinated ligands (8L)

Non-Chelate forming reactions- Reactions of donor atoms (Halogenations of coordinated N atoms, alkylation of coordinated S and N atoms, solvolysis of coordinated P atoms), Reactions of non-donor atoms, Nuclear behaviour of ligand, Electrophilic behaviour of the ligand. Chelate ring forming reactions-Reactions Predominantly involving thermodynamic template effects, reactions predominantly involving kinetic effects, Chelate modifying reactions.

Unit 2: Inorganic polymers: (8L)

Bridge between small and infinite molecules, homopolar inorganic polymers (polyborane and polysilylenes), heteroboranes, Heteropolar inorganic polymers rings and chains containing nitrogen, oxianions and polyoxianions, silicones and biominerals.

Unit 3: Immobilization of transition metal complex catalyst on Inorganic support: (4L)

Anchored catalysts. Industrial applications of heterogeneous catalysis.

Unit 4: Photo catalysis using semiconducting oxides: (4L)

Introduction, Definition of photocatalysis, Basic principle involved in photocatalysis, mechanism of photocatalysis, application of photocatalysis in various fields such as water remediation, air cleaning, etc

References:

1. N.H. Ray, Inorganic Polymers academic press(1978)
2. I.S. Butler and J.F. Harrod, Inorganic chemistry-Principles and applications, the Benjamin/Cummings publishing Co., Inc., redwood city, California (USA) 1989 Chapt 15 to 173.
3. Inorganic Chemistry-Principles of structure and reactivity, J .E. Huheey, E.A. Keiterand R. L. Keiter 4th Edn. Harper Collins publication New York.

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry

Course: Advanced topics in Inorganic Chemistry **Course Code**: CHI-611-MJE (B)

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	0	3	0	0	0	0	0	0
CO2	3	2	0	0	0	0	0	0	0	0
CO3	3	0	0	2	0	0	0	0	0	0
CO4	0	2	3	0	3	2	3	0	0	0
CO5	2	3	3	3	0	2	0	0	0	3
CO6	0	2	2	2	3	3	2	0	0	3
CO7	3	0	3	3	0	2	3	0	0	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Students understand descriptive chemistry of inorganic polymer.

CO3: Students can define various types of chemical bonds

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO7: To investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

PO2: Practical, Professional and Procedural knowledge

CO1: Students understand descriptive chemistry of inorganic polymer.

CO2: Student will be able to classify inorganic polymers.

CO4: Students investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO4: Student investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: Student will be able to classify inorganic polymers.

CO3: Students can define various types of chemical bonds

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation

PO5: Research, Analytical Reasoning and Ethical Conduct

CO4: Student investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

PO6: Communication, Collaboration and Leadership

CO4: Student investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Students apply their knowledge to prepare inorganic polymer in laboratory.

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

PO7: Digital Proficiency and Technological skills

CO4: Student investigate the mechanism of catalytic reactions involving immobilised transition metal complexes.

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

PO10: Autonomy, Responsibility and Accountability

CO5: Recognise PN compounds and polymers and to interpret synthetic methods

CO6: Student apply their knowledge to prepare inorganic polymer in laboratory

CO7: to investigate the potential applications of inorganic polymers in fields such as catalysis and environmental remediation.

CBCS Syllabus as per NEP 2020 for M.Sc. II
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Elective Practicals
Course Name	**:** Inorganic Chemistry Practicals -I
Course Code	**:** CHI-612-MJE (A)
No. of Lectures	**:** 30 (24+6T)
No. of Credits	**:** 2 credits

Course Objectives:

- Students should able to know various instrumental methods of analysis.
- Students should able to introduce methods of chemical analysis.
- Students should able to select procedure for analysis, identify sources possible errors in the result obtained.
- Students should able to introduce methods of chemical analysis.
- Students should able to know various instrumental methods of analysis.
- Students will gets an opportunities to handle and understand principles of different instruments.
- Exercise their critical thinking in creating new knowledge.
- Effectively communicate the knowledge of their study and research in their respective disciplines.

Course Outcomes

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO4: To inculcate complence and reliability in students.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown samples

Topics and Learning Points

1. Analysis of talcum powder for Mg by complexometric titration.
2. Determination of Stability constant of complex ion in solution: Fe(III)-Salicylic acid
3. Preparation of hexa amine nickel (II) chloride
4. Interpretation of IR spectrum with reference to stretching vibrations C=N, C=O, M-O.
5. Interpretation of Mossbauer spectrum with reference to determination of a) isomer shift
   b) quadrapole splitting
6. Measurement of P^H different solutions like fruit juices, soaps using P^H meter.
7. Flame photometric estimation of each Na, K from given sample of binary mixture by standard addition method.
8. Flame photometric estimation of each Ca, Mg from given sample of binary mixture by standard addition method.
9. Determination of Calcium from POP.
10. Determination of iron by solvent extraction technique in a mixture of Fe^{3+}+Al^{3+} using 8- Hydroxyquinoline .
11. To study the absorption spectra of $[Ni(en)_3]^{2+}$,$[Ni(NH_3)_6]^{2+}$,$[Ni(H_2O)_6]^{2+}$ions .
12. Determination of magnetic susceptibility by Gouy method: $CuSO_4$
13. To verify Debye -Huckel theory of ionic conductance for strong electrolytes using KCl, $BaCl_2$.
14. Determination of Assay of paracetamol by UV
15. Determination of iron from Detergent sample.

References:

1. A textbook of qualitative inorganic analysis :A. I. Vogel
2. Inorganic synthesis–King
3. Synthetic inorganic chemistry: W. L. Jolly
4. Experimental Inorganic chemistry by W. G. Palmer
5. The analysis of minerals and ores of rare elements: W. R. Schoeller, A. R. Powell, Charles, Griffinand company limited.

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Inorganic Chemistry Practical I **Course Code**: CHI-612-MJE (A)
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	0	0	0	0	0	0	0	0
CO2	3	2	0	2	0	2	3	2	0	3
CO3	2	2	3	3	3	2	3	3	3	3
CO4	3	3	0	3	3	3	3	1	0	0
CO5	2	0	0	0	0	3	3	2	0	0
CO6	3	3	2	0	0	0	2	0	0	2
CO7	3	3	3	0	0	0	0	0	3	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: To understand magnetic properties of compound

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate compliance and reliability in students.

PO2: Practical, Professional and Procedural knowledge

CO1: To understand magnetic properties of compound

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments,

identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate complence and reliability in students.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO6: To understand method of analysis of sample by different technique.

CO7: To inculcate complence and reliability in students.

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

PO5: Research, Analytical Reasoning and Ethical Conduct

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

PO6: Communication, Collaboration and Leadership

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

PO7: Digital Proficiency and Technological skills

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum & apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

CO6: To understand method of analysis of sample by different technique.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO2: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO4: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: To do critical thinking by interpretation of XRD spectrum

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO7: To inculcate complence and reliability in students.

PO10: Autonomy, Responsibility and Accountability

CO2: Students will able to trained in proper laboratory safety protocols including handling& disposal of inorganic compounds

CO3: develop critical thinking skills apply their knowledge to troubleshoot experiments, identify source of error & propose improvements to experimental procedure.

CO6: To understand method of analysis of sample by different technique.

CBCS Syllabus as per NEP 2020 for M.Sc. II
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Elective Practicals
Course Name	**:** Inorganic Chemistry Practical -II
Course Code	**:** CHI-612-MJE (B)
No. of Lectures	**:** 30 (24+6T)
No. of Credits	**:** 2 credits

Course Objectives:

- Students should able to know various instrumental methods of analysis.
- Students should able to introduce methods of chemical analysis.
- Students should able to select procedure for analysis, identify sources possible errors in the result obtained.
- Students should able to introduce methods of chemical analysis.
- Students should able to know various instrumental methods of analysis.
- Students will get an opportunity to handle and understand principles of different instruments.
- Exercise their critical thinking in creating new knowledge.
- Effectively communicate the knowledge of their study and research in their respective disciplines.

Course Outcomes:

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO4: To inculcate compliance and reliability in students.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown Samples

Topics and Learning Points

1. To verify Debye -Huckel theory of ionic conductance for strong electrolytes using K_2SO_4 and $K_3[Fe(CN)_6]$.
2. Synthesis and photochemistry of potassium trioxalato ferrate (III) trihydrate.
3. Determination of iron by solvent extraction technique in a mixture of Fe^{3+}+Ni^{2+}using 8-Hydroxyquinoline.
4. Determination of Cu(II) by solvent extraction as dithio carbomate 8-hydroxy quinoline complexes.
5. Preparation of $Ni(o\text{-}phen)_2$
6. Synthesis of TiO_2 $Ticl_4$ by sol-gel method and determine band gap by absorption spectroscopy.
7. ZnO, TiO_2, Fe_2O_3 nanoparticals powder XRD, SEM, TEM (at least one spectra analysis should be done)
8. Estimation of Na_2CO_3 in washing soda by P^H metry.
9. Estimation of Cu using Iodometric method potentiometrically.
10. Estimation of Copper and Fe(III) by spectrophotometric titration
11. Determination of magnetic susceptibility by Gouy method: $MgSO_4$
12. Analysis of water with respect to sulphate and chloride.
13. Determination of organic carbon by soil sample.
14. Removal & kinetics of photocatalytic dye degradation (Methylene blue) by ZnO, TiO_2 photocatalysis.
15. Estimation of Cl^- ions in NaCl / KCl by conductometry .

References:

1. A textbook of qualitative inorganic analysis: A. I. Vogel
2. Inorganic synthesis–King
3. Synthetic inorganic chemistry: W. L .Jolly
4. Experimental Inorganic chemistry by W.G. Palmer
5. The analysis of minerals and ores of rare elements: W.R.Schoeller, A.R.Powell, Charles, Griffin and company limited

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Inorganic Chemistry Practical -II **Course Code**: CHI-612-MJE (B)
Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes (POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	3	0	2	0	0	0
CO2	2	2	2	3	3	3	3	0	0	2
CO3	3	0	3	2	3	0	2	0	0	0
CO4	0	0	0	0	0	3	0	3	3	3
CO5	2	0	3	0	3	2	0	3	3	0
CO6	3	0	2	0	3	0	0	2	0	0
CO7	2	3	0	0	3	0	0	0	0	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Students will be able to train in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown Samples

PO2: Practical, Professional and Procedural knowledge

CO1: Students will be able to train in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments,

Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO7: think critically to find correct method to estimate amount of metals from unknown Samples.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO6: Student will get opportunities to handle and understand principles of different instruments.

PO4: Specialized Skills, Critical thinking and Problem solving

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

CO6: Student will get opportunities to handle and understand principles of different instruments.

CO7: think critically to find correct method to estimate amount of metals from unknown Samples

PO6: Communication, Collaboration and Leadership

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO4: To inculcate compliance and reliability in students.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

PO7: Digital Proficiency and Technological skills

CO1: Students will able to trained in proper laboratory safety protocols including handling & disposal of inorganic compounds

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure.

CO3: To interpret given IR spectrum & apply this to find correct structure of a complex Samples

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO3: To interpret given IR spectrum& apply this to find correct structure of a complex

CO4: To inculcate compliance and reliability in students.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO4: To inculcate compliance and reliability in students.

CO5: Student effectively communicate knowledge of their study and research in their respective disciplines.

PO10: Autonomy, Responsibility and Accountability

CO2: develop critical thinking skills apply their knowledge to troubleshoot experiments, Identify source of error & propose improvements to experimental procedure

CO4: To inculcate compliance and reliability in students.

CO7: think critically to find correct method to estimate amount of metals from unknown Samples

CBCS Syllabus as per NEP 2020 for M.Sc. II
(NEP Pattern)

Name of the Programme	**:** M.Sc. Inorganic Chemistry
Program Code	**:** CHE
Class	**:** M.Sc. II
Semester	**:** III
Course Type	**:** Research Methodology
Course Name	**:** Research project
Course Code	**:** CHI-621-RP
No. of Lectures	**:** 60
No. of Credits	**:** 4 credits

Course Objectives:

- Students should able to know various instrumental methods of analysis.
- Students should able to introduce methods of chemical analysis.
- Students should able to introduce methods of chemical analysis.
- Students should able to know various instrumental methods of analysis.
- Students will get an opportunity to handle and understand principles of different instruments.
- Exercise their critical thinking in creating new knowledge.
- Effectively communicate the knowledge of their study and research in their respective disciplines.

Course Outcomes:

CO1: To understand Research methodology
CO2**:** Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow
CO3: To understand the methods of characterization of metal complexes
CO4: To demonstrate skill and knowledge of current information
CO5: Student should perform experiment accurately and able to perform calculations
CO6: To understand the methods of characterization of metal complexes.
CO7: To interpret given spectrum of IR, XRD, NMR and ESR

Project shall be started at the beginning of the SEM III and will be accessed by monthly for progress and continues evaluation will be made. High standard research work is expected from the project and students are encouraged to publish it in national or international journal of high repute. External and internal examiner will examine the jointly at the time of practical examination.

Choice Based Credit System (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry

Course: Research Project **Course Code**: CHI-621-RP

Weightage: 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

	Programme Outcomes(POs)									
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	0	0	0	0	0
CO2	3	3	3	2	3	0	0	0	0	2
CO3	3	0	2	0	0	0	0	0	0	0
CO4	3	0	0	2	3	0	0	0	0	0
CO5	3	3	2	2	2	0	0	0	2	2
CO6	3	2	2	0	2	0	0	0	0	0
CO7	3	0	0	0	2	0	0	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: To understand Research methodology
CO2**:** Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow
CO3: To understand the methods of characterization of metal complexes
CO4: To demonstrate skill and knowledge of current information
CO5: Student should perform experiment accurately and able to perform calculations
CO6: To understand the methods of characterization of metal complexes.
CO7: To interpret given spectrum of IR, XRD, NMR and ESR

PO2: Practical, Professional and Procedural knowledge

CO3: To understand the methods of characterization of metal complexes
CO4: To demonstrate skill and knowledge of current information
CO5: Student should perform experiment accurately and able to perform calculations
CO6: To understand the methods of characterization of metal complexes.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: To understand Research methodology
CO2**:** Student enhance to demonstration ability in authentic context and make consider decision about which possibilities to follow
CO3: To understand the methods of characterization of metal complexes

CO5: Student should perform experiment accurately and able to perform calculations
CO6: To understand the methods of characterization of metal complexes.

PO4: Specialized Skills, Critical thinking and Problem solving

CO1: To understand Research methodology
CO2**:** Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow
CO4: To demonstrate skill and knowledge of current information
CO5: Student should perform experiment accurately and able to perform calculations

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: To understand Research methodology
CO2**:** Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow
CO4: To demonstrate skill and knowledge of current information
CO5: Student should perform experiment accurately and able to perform calculations
CO6: To understand the methods of characterization of metal complexes.
CO7: To interpret given spectrum of IR, XRD, NMR and ESR

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO5: Student should perform experiment accurately and able to perform calculations

PO10: Autonomy, Responsibility and Accountability

CO5: Student should perform experiment accurately and able to perform calculation
CO2: Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follo**w**