Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science, Commerce, Baramati

(Empowered Autonomous)

DEPARTMENT OF CHEMISTRY

(Faculty of Science and Technology)

Two Year M.Sc. Degree Program Chemistry

M.Sc. II Inorganic Chemistry

Sem (IV)

(NEP Pattern)

Choice Based Credit System Structure and Syllabus

(To be implemented from June 2024)

Title of the Programme:

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.

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

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Commerce and Science, Baramati Dist- Pune.
(Empowered Autonomous)
Course & Credit Structure for M.Sc. Inorganic Chemistry (2023 Pattern as per NEP-2020)

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-653-MJM	Extended Practical in Inorganic Chemistry I	Practical	02
	Major (Elective)	CHI-661-MJE (A)	Environmental Chemistry	Theory	02
		CHI-661-MJE (B)	Industrial applications in Inorganic chemistry		
	Major (Elective)	CHI-662-MJE (A)	Inorganic chemistry Practical III OR	Practical	02
		CHI-662-MJE (B)	Inorganic chemistry Practical IV		
	Research Project	CHI-681-RP	Research Project (RP)	Project	06
			Total Credits Semester IV		**20**
			Cumulative Credits of Semester III and IV		**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	IV
Course Type	**:** Mandatory Theory
Course Name	**:** Homogeneous and heterogeneous catalysis
Course Code	**:** CHI-651-MJM
No. of Lectures	**:** 60
No. of Credits	**:** 4 credits

Course Objectives:

- Students knows the approaches and various theories in heterogeneous catalysis.
- Students understand the concept of heterogeneous catalysis.
- To understand Descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.
- Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique.
- To understand Heterogeneous catalysis used in Intercalation compounds, Perovskites related oxides, Oxides with Scheelite structure.
- To get knowledge about inorganic polymers.
- To develop problem solving skills in students.

Course Outcomes:

CO1: Student will be able to classify porous materials.
CO2: Student able to understand concept of absorption and adsorption.
CO3: Student should be able to characterize zeolite by using different methods.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO5: Student will get knowledge about homogeneous catalyst
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions
CO7: Student will get knowledge about synthesis, properties, metal carbon bonds, applications.

Topics and Learning Points

Unit 1: **(4L)**

Introduction to catalysis: Basic principle, Definition of activity and selectivity in catalysis, Homogeneous vs. Heterogeneous catalysis, Importance of Homogeneouscatalysis in synthesis of high value chemicals, Characteristics of central metal atom and influence of attached ligands on catalytic activity. Important properties of ligands: Elementary steps, important reaction types, Catalytic cycle, Catalytic intermediates and their identification.

Unit 2: **(8L)**

Hydrogenation of Olefin: Isomerization, Dimerization, Hydrocyanation and Metathesis reaction, Carbonylation reaction: Monsanto acetic acid process and its industrial importance. Hydroformylation reaction in Rhodium complexes, Role of phosphine ligand in regioselective formation of ligand aldehyde. Hydroformylation reaction in Rhodium complexes, Role of phosphine ligand in regioselective formation of ligand aldehyde.

Unit 3: **(12L)**

Polymerization: Catalytic cycle for alkene Polymerization, Metallocene catalysts structure and special features, advantages of Metallocene catalysis, Mechanism of polymerization and stereo control by Metallocene catalyst. C-C coupling : Cativa process, Heck reaction, Suzuki cross coupling reaction, Negeshi reaction, Sonogashira reaction, Kumada coupling reaction

Unit 4: **(6L)**

Descriptive chemistry of Heterogeneous Catalysis:

Definition of catalysis, Classification of Catalytic systems, adsorption of molecules on solid surfaces, PE curves for adsorption, descriptive chemistry of chemisorption on metals, chemisorption and catalysis by metals-semi quantitative aspects, catalysis by supported and unsupported bimetals, adsorption and catalysis on semiconducting oxides, selective oxidation of hydrocarbons, Different types of reactors.

Unit 5: **(12L)**

Zeolite compounds and heterogenous catalysis:

Introduction to meso-porous & micro porous materials: classification into micro meso and macroporous material the origin pore and its significance. Zeolites-Definition, types, natural and synthetics zeolites and aluminosilicate, primary and secondary building blocks, final framework structure, Lowenstein rule, sodalite and other structure, nomenclature, example of small, medium, large and extra-large pore zeolites general properties and application of molecular sieve.

Unit 6: **(6L)**

Heterogeneous catalysis : Heterogeneous catalysis using intercalation compounds**.-**
General aspects of interstial Compounds of graphite, structural aspects of graphite intercalation compound, physical and chemical properties, catalytic reactions.
Heterogenous catalysis using Perovskite related oxides **-**
Solid state properties of perovskite's like oxides, relation of solid state and catalytic properties of perovskite

References:

1. Homogeneous Catalysis - G.W.Parshall
2. Heterogeneous catalysts – principles and applications – G. C. Bond
3. Introduction to Zeolite Science and Practice – H. Van Bekkum, E. M. Flanigen, P. A.Jacobs and J. C. Jahnson, Elsevier, Amsterdam, 2001.
4. Catalysis – Principles and applications – B. Vishwanath, S. Shivshankar and A. V. Ramaswamy, Narosa Publishing House, New Delhi, 2004.
5. Advanced Materials in Catalysis – J. J. Burton, R. L. Garten, Academic Press, New York, 1977.
6. Handbook of Heterogeneous Catalysis: Wiley International Wiley-VCH Verlag GmbH & Co. KGaA,2008
7. Catalysis: Concept and Green applications: Gadi Rothenberg, Wiley VCH: First edition, 2015
8. Heterogeneous Catalysis for the Synthetic chemist By Robert L. Augustine, Marcel Dekkar Inc. New York, 1996

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject**: Inorganic Chemistry

Course: Homogeneous and heterogeneous catalysis **Course Code**: CHI-651-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	2	0	0	0	0	0	0	0
CO2	3	3	3	0	2	0	0	0	0	0
CO3	3	0	2	2	2	0	2	0	0	0
CO4	3	3	2	3	0	0	0	0	0	0
CO5	3	0	2	2	0	0	0	0	0	0
CO6	3	3	2	2	2	0	3	0	0	0
CO7	3	0	0	2	0	0	2	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Student will be able to classify porous materials.
CO2: Student able to understand concept of absorption and adsorption.
CO3: Student should be able to characterize zeolite by using different methods.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO5: Student will get knowledge about homogeneous catalyst
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions
CO7: Student will get knowledge about synthesis, properties, metal carbon bonds, applications

PO2: Practical, Professional and Procedural knowledge

CO1: Student will be able to classify porous materials.
CO2: Student able to understand concept of absorption and adsorption.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: Student will be able to classify porous materials.
CO2: Student able to understand concept of absorption and adsorption.
CO3: Student should be able to characterize zeolite by using different methods.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO5: Student will get knowledge about homogeneous catalyst
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions

PO4: Specialized Skills, Critical thinking and Problem solving

CO3: Student should be able to characterize zeolite by using different methods.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO5: Student will get knowledge about homogeneous catalyst
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions
CO7: Student will get knowledge about synthesis, properties, metal carbon bonds, applications

PO5: Research, Analytical Reasoning and Ethical Conduct

CO2: Student able to understand concept of absorption and adsorption.
CO3: Student should be able to characterize zeolite by using different methods.
CO4: Student should be able to understand concepts of chemisorption, physisorption.
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions
CO7: Student will get knowledge about synthesis, properties, metal carbon bonds, applications

PO7: Digital Proficiency and Technological skills

CO3: Student should be able to characterize zeolite by using different methods.
CO6: Understand the essential properties of homogeneous catalyst- Zeigler Natta, c-c coupling reactions
CO7: Student will get knowledge about synthesis, properties, metal carbon bonds, applications

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	**:** IV
Course Type	**:** Mandatory Theory
Course Name	**:** Material Science -I Solid state chemistry
Course Code	**:** CHI-652-MJM
No. of Lectures	**:** 60
No. of Credits	**:** 4 credits

Course Objectives:

- To get knowledge about structure of solid and crystal defects.
- To understand Magnetic materials, types, and applications.
- To study about electronic and optical materials, Superconducting materials, ceramic materials, composite materials, Biomaterials and Meta materials
- To find spinel structure of given metal ferrites
- To differentiate between magnetic materials.
- To understand the optical materials and their properties.
- To identify defect in solid.

Course Outcomes:

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

CO1: Student should understand the types of crystal defects.
CO2: Analyze the properties and applications of superconducting, ceramic, magnetic, and composite materials to solve complex engineering problems.
CO3: Design and execute experiments to investigate the behavior of ceramic and magnetic materials under different conditions.
CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.CO5: Student should understand method of finding type of spinel of given compound.
CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.
CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.
CO7: Demonstrate responsibility in the handling and disposal of materials used in experiments and projects, adhering to safety and environmental regulations.

Topics and Learning Points

Principles, Instrumentation & Applications of the following techniques,

Unit 1: **(8L)**

Structure of solids and crystal defect:

The types of matter, classification of solids, structure of ionic crystals, Ionic crystals with stoichiometry MX, MX_2, spinel structure, perovskite structure

Crystal defect:

Classification of defect, calculation of no. of defects and average energy required for defect, diffusion in solids: Fick's first and second law of diffusion in solids.

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Unit 2: **(7L)**

Magnetic materials:

Magnetism in solids, hysteresis loop and their classification, soft and hard ferrites, spinels, garnets, applications of magnetic materials.

Unit 3: **(8L)**

Electronic and optical materials:

Electronic materials and applications

Conductivity: conductors, insulators, semiconductors, superconductors, temperature dependent conductivity. Applications of semiconducting devices: metal-metal junction i.e., Peltier effect and seebeck effect, diodes, transistors, metal-semiconductor junction

Optical materials and their properties - Photonic devices, photoluminescence, crystalline laser.

Unit 4: **(8L)**

Superconducting materials:

Definition of superconductivity, critical temperature, BCS theory, properties and classification of superconducting materials, High Tc superconductivity, Low Tc superconductivity, superconducting oxides, intermetallic superconductors, and applications.

Unit 5: **(8L)**

Ceramic materials:

Classification, dielectric properties, polarization properties, Piezo, Pyro, and ferroelectric effect of ceramics, sol-gel processing of ceramics, applications as oxides, carbides, borides, and nitrides

Unit 6: **(9L)**

Composite materials:

Definition, glass transition temperature, fibers for reinforced plastic composite materials, application as glass fiber, carbon fiber, aramid fibers, polymer composites

Biomaterials –

Definition, types, bioactive glasses, bioactive glasses and bioactive composites, application of biomaterials

References:

1. Solid state chemistry by L. V. Azaroff
2. Material science and engineering by V. Raghavan
3. Inorganic chemistry by J. E. Huheey
4. Solid state chemistry by L. Smart and E. Moore
5. Solid state chemistry by D. K. Chakraborty
6. Solid state chemistry and its applications by A. R. West, John willey and sons Singapore
7. Elements of material science and engineering- Van Vleck (5^{th} edition, Wiley 1988)

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject**: Inorganic Chemistry
Course: Material Science -I Solid state chemistry Chemistry **Course Code**: CHI-652-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	0	2	2	3	3	0	0	0	0	0
CO3	0	2	3	2	2	0	0	0	0	0
CO4	2	1	3	3	2	0	3	0	3	0
CO5	0	2	0	3	1	2	2	0	3	0
CO6	2	3	0	0	0	3	1	0	2	3
CO7	0	0	2	0	0	1	0	0	3	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding.
CO1: Student should understand the types of crystal defects.
CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.
CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

PO2: Practical, Professional and Procedural knowledge
CO1: Student should understand the types of crystal defects.
CO2: Analyze the properties and applications of superconducting, ceramic, magnetic, and composite materials to solve complex engineering problems.
CO3: Design and execute experiments to investigate the behavior of ceramic and magnetic materials under different conditions.
CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.
CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.
CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding
CO2: Analyze the properties and applications of superconducting, ceramic, magnetic, and composite materials to solve complex engineering problems.
CO3: Design and execute experiments to investigate the behavior of ceramic and magnetic materials under different conditions.
CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for

superconductors and ceramics.

CO7: Demonstrate responsibility in the handling and disposal of materials used in experiments and projects, adhering to safety and environmental regulations**.**

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: Analyze the properties and applications of superconducting, ceramic, magnetic, and composite materials to solve complex engineering problems.

CO3: Design and execute experiments to investigate the behavior of ceramic and magnetic materials under different conditions.

CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.

CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO2: Analyze the properties and applications of superconducting, ceramic, magnetic, and composite materials to solve complex engineering problems.

CO3: Design and execute experiments to investigate the behavior of ceramic and magnetic materials under different conditions.

CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.

CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.

PO6: Communication, Collaboration and Leadership

CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.

CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

CO7: Demonstrate responsibility in the handling and disposal of materials used in experiments and projects, adhering to safety and environmental regulations.

PO7: Digital Proficiency and Technological skills

CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.

CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.

CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO4: Assess the ethical implications of material sourcing and manufacturing processes, particularly for superconductors and ceramics.

CO5 : Conduct literature reviews and synthesize findings on recent advancements in superconducting and composite materials.

CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

CO7: Demonstrate responsibility in the handling and disposal of materials used in experiments and projects, adhering to safety and environmental regulations.

PO10: Autonomy, Responsibility and Accountability

CO6: Propose sustainable practices in the development and application of superconducting, ceramic, magnetic, and composite materials.

CO7: Demonstrate responsibility in the handling and disposal of materials used in experiments and projects, adhering to safety and environmental regulations.

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	IV
Course Type	**:** Mandatory Practical
Course Name	**:** Extended practical in inorganic chemistry I
Course Code	**:** CHI-653-MJM
No. of Lectures	**:** 60
No. of Credits	**:** 2 credits

Course Objectives:

- To understand Methods of inorganic estimations.
- To understand Methods of Inorganic preparations.
- To understand the methods of characterization of metal complexes
- To interpret given IR spectrum
- To interpret given XRD spectrum
- To understand handling of UV, IR magnetic susceptibility

Course Outcomes:

After successfully completing this course students will know,

CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.

CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

CO3: Perform calculations and discuss results and write conclusion of the experiment.

CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

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

CO6: To understand method to perform case study.

CO7: Students will develop problem solving skills by troubleshooting synthesis and purification issues encountered during practical work.

Topics and Learning Points

A. 1) Preparation and purity of complexes

1. Dimethylglyoxime with Cu, Ni, Mn
2. 8-hydroxyquinoline with Cu, Ni, Mn
3. Salicylaldoxime with Cu, Ni, Mn
4. Thiourea with Cu, Ni, Mn

2) Structural determination of above complexes using following techniques:

1. UV-visible spectroscopy
2. Magnetic susceptibility
3. IR spectroscopy

B. Table work: Spectral interpretation of some solid crystalline substances.

1. XRD
2. NMR
3. IR
4. ESR

C. Case Study

(Note: Minimum 15 experiments should be completed in this course.)

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject:** Inorganic Chemistry
Course: Extended Practicals in Inorganic Chemistry I **Course Code**: CHI-654-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	1	3	2	3	0
CO5	0	0	0	1	2	3	3	2	2	2
CO6	0	0	0	0	2	0	0	0	2	1
CO7	0	0	0	3	1	0	0	0	0	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding.
CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

PO2: Practical, Professional and Procedural knowledge
CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding
CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.
CO3: Perform calculations and discuss results and write conclusion of the experiment.
CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

PO4: Specialized Skills, Critical thinking and Problem solving.
CO3: Perform calculations and discuss results and write conclusion of the experiment.
CO5: Student should perform experiment accurately and able to perform calculations.
CO7: Students will develop problem solving skills by troubleshooting synthesis and purification issues encountered during practical work.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: Students will be able to Prepare solution of required concentration and handle the laboratory equipment.

CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

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

CO6: To understand method to perform case study.

CO7: Students will develop problem solving skills by troubleshooting synthesis and purification issues encountered during practical work.

PO6: Communication, Collaboration and Leadership

CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

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

PO7: Digital Proficiency and Technological skills

CO2: Student able to calculate the quantity from observation of the experiment and interpret the result.

CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

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

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

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

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO4: To interpret given spectrum of IR, XRD, NMR and ESR.

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

CO6: To understand method to perform case study.

PO10: Autonomy, Responsibility and Accountability

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

CO6: To understand method to perform case study.

CO7: Students will develop problem solving skills by troubleshooting synthesis and purification issues encountered during practical work.

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	**:** IV
Course Type	**:** Elective Theory
Course Name	**:** Environmental chemistry
Course Code	**:** CHI-661-MJE (A)
No. of Lectures	30
No. of Credits	**:** 2 credits

Course Objectives:

- Understand the fundamental principles of environmental chemistry and their applications.
- Identify and analyze environmental pollutants and their sources.
- Examine the fate and transport of pollutants in the environment.
- Evaluate the impact of human activities on the environment and ecosystem.
- To understand the principle of sustainability and green chemistry.
- To apply analytical techniques and instrumentation for environmental monitoring.
- To develop strategies for pollution prevention and control.
- To develop critically evaluate environmental issues and develop solutions.

Course Outcomes:

CO1: Student will be able to explain the different types of water pollutants, their sources and regulation governing water quality.

CO2: Utilize biotechnology method for treating various waste water components like high strength waste, sludge and specific contaminants such as phenol and cyanide.

CO3: To analyze environmental data and samples to draw meaningful conclusions.

CO4: To access the effectiveness of pollution prevention and control strategies.

CO5: To work effectively in a team to develop solutions to environmental problems.

CO6: Participate in group discussion and debates on environmental issues.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

Topics and Learning Points

Unit 1: (12L)

Introduction to wastewater analysis and wastewater engineering for biological treatment. Biotechnology and wastewater management: Applications of biotechnology for the treatment of: high strength waste, primary and secondary sludge, Phenol and cyanide removal, solid phase extraction.

Unit 2: (6L)

Bioaccumulation of toxic metals Pb, Hg, Cd, As, energy sources for the future- Fuel cells and clean cars for the future (Power ball) Bioaccumulation of organic pollutants.

Unit 3: (6L)

Green Chemistry: Introduction designing a green synthesis basic principle of green chemistry, green chemistry in day-to-day life, green chemistry in a sustainable development

References:

1. Environmental chemistry by Girard
2. Textbook of environmental chemistry by Balram Pani
3. Insight into specialty inorganic chemicals by David Thomson
4. Environmental chemistry by Stanley Manahan 10th edition.
5. New trends in a green chemistry(2nd edition) – V.K.Ahluwalia and M.Kidwai (Anamaya Publishers), 2007

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject**: Inorganic Chemistry
Course: Environmental Chemistry **Course Code**: CHI-661-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	0	0		0	0	0	0	0	0
CO2	1	2	0	2	0	0	0	0	0	0
CO3	0	2	3	1	3	0	0	0	0	0
CO4	0	2	3	1	2	0	0	0	0	0
CO5	2	3	0	3	1	2	0	2	0	3
CO6	0	0	0	0	0	3	0	0	0	3
CO7	0	1	2	3	3	0	0	3	0	2

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Student will be able to explain the different types of water pollutants, their sources and regulation governing water quality.

CO2: Utilize biotechnology method for treating various waste water components like high strength waste, sludge and specific contaminants such as phenol and cyanide.

CO5: To work effectively in a team to develop solutions to environmental problems.

PO2: Practical, Professional and Procedural knowledge

CO2: Utilize biotechnology method for treating various waste water components like high strength waste, sludge and specific contaminants such as phenol and cyanide.

CO3: To analyze environmental data and samples to draw meaningful conclusions.

CO4: To access the effectiveness of pollution prevention and control strategies.

CO5: To work effectively in a team to develop solutions to environmental problems.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO3: To analyze environmental data and samples to draw meaningful conclusions.

CO4: To access the effectiveness of pollution prevention and control strategies.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

PO4: Specialized Skills, Critical thinking and Problem solving

CO2: Utilize biotechnology method for treating various waste water components like high strength waste, sludge and specific contaminants such as phenol and cyanide.

CO3: To analyze environmental data and samples to draw meaningful conclusions.

CO4: To access the effectiveness of pollution prevention and control strategies.

CO5: To work effectively in a team to develop solutions to environmental problems.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO3: To analyze environmental data and samples to draw meaningful conclusions.

CO4: To access the effectiveness of pollution prevention and control strategies.

CO5: To work effectively in a team to develop solutions to environmental problems.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

PO6: Communication, Collaboration and Leadership

CO5: To work effectively in a team to develop solutions to environmental problems.

CO6: Participate in group discussion and debates on environmental issues.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO5: To work effectively in a team to develop solutions to environmental problems.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

PO10: Autonomy, Responsibility and Accountability

CO5: To work effectively in a team to develop solutions to environmental problems.

CO6: Participate in group discussion and debates on environmental issues.

CO7: To develop innovative solution to environmental problems using green chemistry principles.

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	IV
Course Type	**:** Elective Theory
Course Name	**:** Industrial applications in Inorganic chemistry
Course Code	**:** CHI-661-MJE (B)
No. of Lectures	30
No. of Credits	**:** 2 credits

Course Objectives:

- To understand introduction, Classifications and applications of Dyes and pigment.
- To get knowledge about electrochemical applications.
- To get knowledge about wastewater management technique.
- To study about bioaccumulation of toxic metal, energy sources
- To get knowledge about photographic products industry.
- To get knowledge about methods of electrodeposition of various metals.

Course Outcomes:

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

CO1: Student should understand the concept of dyes and pigments.
CO2: Students get knowledge about various types of dyes their types and applications.
CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.
CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.
CO5: Students will understand applications of dyes and pigments in various industries including textiles, coatings, plastics and food.
CO6: Students will assess how environmental conditions (temp and P^H) influence electrochemical reactions in photographic process
CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

Topics and Learning Points

Unit 1: 12L

Dyes and Pigments:

a) Dyes: Introduction, classification of dyes, applications in industry

b) Pigments: Introduction, pigments in food, naturally occurring plants and animal pigments, synthetic food pigments such as sunset yellow, allura red etc., pigments in plants, raw materials for paints, physical properties of pigments in paints, brief description of manufacturing process of commonly used pigments as a white lead, ZnO, TiO_2 etc.

Unit 2 : **6L**

Electrochemical applications:

Introduction, brief discussion on classical electrodeposition of metals.

Unit 3: **6L**

Photographic Products Industry:

Introduction, Conventional silver halide-based photography, Color photography, Special applications of photography such as photochemical reproduction, photolithography, photo conversion, electro photography.

References:

1. Handbook of industrial chemistry by K. H.Davis, F. S. Bernel, CBS Publishers Bangalore
2. Industrial inorganic chemistry, Karl Heinz Buchel, Hans-Heinrich Moretto, Peter woditsch
3. Modern Electroplating, by M. Schlesinger and M. Paunovic (John Wiley and sons, Hoboken, New Jersey, 5th Edition 2010
4. New trends in Green Chemistry (2nd Edition)- V.K. Ahluwalia and M. Kidwai

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject**: Inorganic Chemistry
Course: Industrial applications in Inorganic chemistry **Course Code**: CHI-661-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	3	2	0	0	0	0	0	0
CO2	0	1	2	0	0	0	0	0	0	0
CO3	2	3	0	0	3	2	3	0	0	2
CO4	3	0	3	3	2	3	3	0	0	2
CO5	3	1	0	0	0	0	0	0	0	0
CO6	0	0	2	2	2	0	2	0	0	0
CO7	0	3	3	2	2	3	2	0	0	1

Justification for the mapping

PO1: Comprehensive knowledge and understanding.

CO1: Student should understand the concept of dyes and pigments.
CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.
CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.
CO5: Students will understand applications of dyes and pigments in various industries including textiles, coatings, plastics and food.

PO2: Practical, Professional and Procedural knowledge

CO1: Student should understand the concept of dyes and pigments.
CO2: Students get knowledge about various types of dyes their types and applications.
CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.
CO5: Students will understand applications of dyes and pigments in various industries including textiles, coatings, plastics and food.
CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

CO1: Student should understand the concept of dyes and pigments.
CO2: Students get knowledge about various types of dyes their types and applications.
CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.
CO6: Students will assess how environmental conditions (temp and P^H) influence electrochemical reactions in photographic process
CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

PO4: Specialized Skills, Critical thinking and Problem solving

CO1: Student should understand the concept of dyes and pigments.

CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.

CO6: Students will assess how environmental conditions (temp and P^H) influence electrochemical reactions in photographic process

CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

PO5: Research, Analytical Reasoning and Ethical Conduct

CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.

CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.

CO6: Students will assess how environmental conditions (temp and P^H) influence electrochemical reactions in photographic process

CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

PO6: Communication, Collaboration and Leadership

CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.

CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.

CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

PO7: Digital Proficiency and Technological skills

CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.

CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.

CO6: Students will assess how environmental conditions (temp and P^H) influence electrochemical reactions in photographic process

CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agent.

PO10: Autonomy, Responsibility and Accountability

CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.

CO4: Students will utilize analytical technique to characterize the properties and purity of dyes and pigment.

CO7: Student will explain the electrochemical processes involved in photographic products such as the role of silver halides in a film and mechanism of developing agents

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	IV
Course Type	**:** Elective Practical
Course Name	**:** Inorganic Chemistry Practicals -III
Course Code	**:** CHI-662-MJE (A)
No. of Lectures	60
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 Outcome

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. Assay of thiamine from given sample.
2. Analysis of quinine sulphate from given tablet by photo fluorimetry.
3. Estimation of tannin from given sample.
4. Estimation of iron from syrup sample by spectrophotometric method.
5. Estimation of HMF from Honey sample.
6. Determination of total acidity in juice.
7. Determination of glucose from glucon-D by titration with Fehling method.
8. Estimation of protein from food sample by Lowery method.
9. Ion exchange chromatography (Separation and estimation of mixture of anion)
10. Pharmaceutical Product – Determination of magnesium from tablet of milk magnesia.
11. Determination of Zinc from iron zinc supplementary capsule or tablet.
12. Determination of curcumin from turmeric powder by Soxhlet apparatus method.
13. Determination of Lactose by colorimetric method in milk-based sweets.
14. Estimation of Phosphate from Fertilizer sample
15. Synthesis of oxide nanoparticles by green synthesis method using plant extract.
16. To study complex formation between Fe(III) with sulphosalicylic acid conductometrically.
17. Determinatilon of Cu(II) by solvent extraction as dithiocarbamate / 8- hydroxyquinoline complex

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 IV) **Subject**: Inorganic Chemistry
Course: Inorganic Chemistry Practical III **Course Code**: CHI-662-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	2	2	2	1	2	2
CO2	3	2	3	2	2	3	3	0	0	3
CO3	1	0	0	3	3	0	3	0	0	0
CO4	2	0	0	0	0	0	0	2	0	0
CO5	3	3	3	0	2	2	0	2	0	0
CO6	3	0	2	3	3	0	0	0	0	0
CO7	3	3	3	2	0	0	0	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and 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

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

PO2: Practical, Professional and Procedural knowledge

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.

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

PO3: Entrepreneurial Mindset, Innovation and Business Understanding

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

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

PO4: Specialized Skills, Critical thinking and Problem solving

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

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: 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.

PO6: Communication, Collaboration and Leadership

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.

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

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

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

CO4: To inculcate complence 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

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

PO10: Autonomy, Responsibility and Accountability

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

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	IV
Course Type	**:** Elective Practical
Course Name	**:** Inorganic Chemistry Practical -IV
Course Code	**:** CHI-662-MJE (B)
No. of Lectures	60
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 Outcome

CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.
CO2: Students will demonstrate a comprehensive understanding of key concepts in inorganic chemistry, including the properties, synthesis, and reactivity of inorganic compounds.
CO3: Students will show mastery of the procedural aspects of laboratory work, including proper safety practices and waste disposal methods.
CO4: Students will apply critical thinking skills to solve complex problems related to inorganic chemistry, including troubleshooting experimental procedures.
CO5: Students will exhibit independence in planning and executing experiments, taking responsibility for their learning outcomes and laboratory practices.
CO6: Students will collaborate effectively in groups to conduct experiments, demonstrating the ability to share responsibilities and support each other's learning.
CO7: students will apply quantitative analysis methods (e.g., titration, gravimetric analysis) to accurately estimate the concentration of inorganic species in various samples.

Topics and Learning Points

1. Determination of amount of each copper and bismuth from given mixture by spectrophotometric titration by using standard EDTA solution.
2. Determination of strength of phosphoric acid by potentiometric titration using standard solution of NaOH.
3. Determination of boric acid by conductometry.
4. Determination of concentration of Riboflavin in the given sample by spectrophotometry.
5. To estimate ketone bodies from given sample.
6. P^H metric titration of anthranilic acid with NaOH.
7. Analysis of caffeine by spectrophotometric method.
8. Determination of the percentage of sodium, Potassium, Calcium in the water sample by flame photometry.
9. Synthesis of oxide nanoparticles by green synthesis method using plant extract.
10. Estimation of Vitamin C by reaction with Fe (III) & Estimation of Fe (II) colorimetrically.
11. Determination of phosphate in detergent by spectrophotometry
12. Interpretation of XRD spectrum of inorganic compounds
13. Quantitative analysis using cyclic voltammetry of Vit. C OR Nitrobenzene
14. Estimation of Calcium from calcium supplementary tablet
15. To separate out given amino acid by using 2D Paper chromatography
16. Determination of equilibrium constant of M-L system Fe(III) ß- resorcylic acid by Jobs continuous variation method.
17. Estimation of phosphate from waste water sample by calibration curve method.

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
6. Vit.C as a model for a novel and approachable experimental framework for investigating spectrophotometry, Journal of chemical education. DOI: 10:1021/acs.jchemed.9b00197

Choice Based Credit System Syllabus (NEP Pattern)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem IV) **Subject**: Inorganic Chemistry
Course: Inorganic Chemistry Practical IV **Course Code**: CHI-662-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	0	2	2	0	2	0	0	2	2	0
CO2	3	0	3	0	2	0	0	0	0	0
CO3	1	0	3	0	0	0	0	0	2	0
CO4	0	0	0	3	0	0	2	0	0	0
CO5	0	3	0	0	2	0	0	2	2	0
CO6	2	2	2	0	3	0	0	0	0	0
CO7	2	0	3	2	0	0	2	0	0	0

Justification for the mapping

PO1: Comprehensive knowledge and understanding.
CO2: Students will demonstrate a comprehensive understanding of key concepts in inorganic chemistry, including the properties, synthesis, and reactivity of inorganic compounds.
CO3: Students will show mastery of the procedural aspects of laboratory work, including proper safety practices and waste disposal methods.
CO6: Students will collaborate effectively in groups to conduct experiments, demonstrating the ability to share responsibilities and support each other's learning.
CO7: students will apply quantitative analysis methods (e.g., titration, gravimetric analysis) to accurately estimate the concentration of inorganic species in various samples.

PO2: Practical, Professional and Procedural knowledge
CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.
CO3: Students will show mastery of the procedural aspects of laboratory work, including proper safety practices and waste disposal methods.
CO5: Students will exhibit independence in planning and executing experiments, taking responsibility for their learning outcomes and laboratory practices.
CO6: Students will collaborate effectively in groups to conduct experiments, demonstrating the ability to share responsibilities and support each other's learning.

PO3: Entrepreneurial Mindset, Innovation and Business Understanding
CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.
CO2: Students will demonstrate a comprehensive understanding of key concepts in inorganic chemistry, including the properties, synthesis, and reactivity of inorganic compounds.
CO3: Students will show mastery of the procedural aspects of laboratory work, including proper safety practices and waste disposal methods.
CO6: Students will collaborate effectively in groups to conduct experiments, demonstrating the ability to

share responsibilities and support each other's learning.
CO7: students will apply quantitative analysis methods (e.g., titration, gravimetric analysis) to accurately estimate the concentration of inorganic species in various samples.

PO4: Specialized Skills, Critical thinking and Problem solving

CO4: Students will apply critical thinking skills to solve complex problems related to inorganic chemistry, including troubleshooting experimental procedures
CO7: students will apply quantitative analysis methods (e.g., titration, gravimetric analysis) to accurately estimate the concentration of inorganic species in various samples.

PO5: Research, Analytical Reasoning and Ethical Conduct

CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.
CO2: Students will demonstrate a comprehensive understanding of key concepts in inorganic chemistry, including the properties, synthesis, and reactivity of inorganic compounds.
CO5: Students will exhibit independence in planning and executing experiments, taking responsibility for their learning outcomes and laboratory practices.
CO6: Students will collaborate effectively in groups to conduct experiments, demonstrating the ability to share responsibilities and support each other's learning.

PO7: Digital Proficiency and Technological skills

CO4: Students will apply critical thinking skills to solve complex problems related to inorganic chemistry, including troubleshooting experimental procedures
CO7: students will apply quantitative analysis methods (e.g., titration, gravimetric analysis) to accurately estimate the concentration of inorganic species in various samples.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.
CO5: Students will exhibit independence in planning and executing experiments, taking responsibility for their learning outcomes and laboratory practices.

PO9: Value Inculcation, Environmental Awareness and Ethical Practices

CO3: Students will show mastery of the procedural aspects of laboratory work, including proper safety practices and waste disposal methods.
CO5: Students will exhibit independence in planning and executing experiments, taking responsibility for their learning outcomes and laboratory practices.
CO1: Students will conduct literature reviews and research projects, enhancing their ability to gather, analyze, and synthesize information from scientific sources.

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	IV
Course Type	**:** Research Project (RP)
Course Name	**:** Research project
Course Code	**:** CHI-681-RP
No. of Lectures	90
No. of Credits	**:** 6 credits

Course Objectives:

1. Enable students to apply analytical chemistry principles to real-world research projects.
2. Cultivate skills in experimental design, data analysis, and interpretation within the realm of analytical chemistry.
3. Encourage students to explore advanced analytical techniques and methodologies.
4. Foster independent thinking and problem-solving abilities in the context of analytical chemistry research.
5. Promote effective communication of research findings through oral presentations and written reports.
6. Facilitate collaboration and teamwork among students in conducting research projects.
7. Prepare students for further academic or professional pursuits in analytical chemistry or related fields.

Course Outcomes:

CO1. Develop a profound understanding of the chosen research topic or project scope, encompassing relevant theories, methodologies, and key concepts within the field of study. Acquire multidisciplinary insights and knowledge from diverse sources, literature reviews, and experimental data to inform the research design and objectives effectively.

CO2. Gain practical skills and expertise necessary for conducting high-quality research, including experimental design, data collection, analysis, and interpretation. Adhere to professional standards, ethical considerations, and procedural guidelines throughout the research process, ensuring rigor, accuracy, and reproducibility of results.

CO3. Cultivate an entrepreneurial mindset by identifying research opportunities, fostering innovation, and exploring novel approaches or solutions to address scientific challenges or knowledge gaps. Understand the broader implications of the research findings, including potential applications, market relevance, and implications for industry or society.

CO4. Demonstrate proficiency in specialized research techniques, analytical methods, and experimental protocols relevant to the chosen research area or project objectives. Apply critical thinking and problem-solving abilities to overcome research obstacles, troubleshoot experimental issues, and adapt methodologies to achieve research goals effectively. Exhibit observational and analytical reasoning skills to formulate research hypotheses, design experimental protocols, and analyse data systematically. Conduct research with integrity, adhering to ethical principles, responsible conduct guidelines, and regulatory requirements to ensure the ethical conduct of research and reporting of

findings.

CO5. Effectively communicate research findings, methodology, and implications to both technical and non-technical audiences through written reports, oral presentations, and visual aids. Collaborate with peers, advisors, and stakeholders to leverage diverse perspectives, resources, and expertise, demonstrating leadership qualities in coordinating research efforts and driving progress toward project objectives.

CO6. Utilize digital tools, software platforms, and technological resources to support research activities, data analysis, and knowledge dissemination throughout the project lifecycle. Embrace technological advancements and digital methodologies to enhance research efficiency, productivity, and the quality of outputs, including publications and presentations.

CO7. Take ownership of the research project, demonstrating autonomy in decision-making, project management, and resource allocation to ensure progress and timely completion. Assume responsibility for project outcomes, including the quality of research outputs, adherence to timelines, and effective utilization of resources, while being accountable to stakeholders, collaborators, and regulatory bodies.

Topics and Learning Points

Project shall be started at the beginning of the SEM IV 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 Syllabus
(NEP Pattern)

Class: M.Sc. II (SEM. IV) **Subject:** Inorganic Chemistry
Course: Research Project **Course Code:** CHI-681-RP
Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	0	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0	0
CO4	0	0	0	3	3	0	0	0	3	3
CO5	0	0	0	0	3	0	0	0	0	0
CO6	0	0	0	0	0	3	3	0	0	0
CO7	0	0	0	0	3	0	0	0	3	3

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding
CO1: Develop a profound understanding of the chosen research topic or project scope, encompassing relevant theories, methodologies, and key concepts within the field of study. Acquire multidisciplinary insights and knowledge from diverse sources, literature reviews, and experimental data to inform the research design and objectives effectively.

PO2: Practical, Professional, and Procedural Knowledge
CO2: Gain practical skills and expertise necessary for conducting high-quality research, including experimental design, data collection, analysis, and interpretation. Adhere to professional standards, ethical considerations, and procedural guidelines throughout the research process, ensuring rigor, accuracy, and reproducibility of results.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
CO3: Cultivate an entrepreneurial mindset by identifying research opportunities, fostering innovation, and exploring novel approaches or solutions to address scientific challenges or knowledge gaps. Understand the broader implications of the research findings, including potential applications, market relevance, and implications for industry or society.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO4: Demonstrate proficiency in specialized research techniques, analytical methods, and experimental protocols relevant to the chosen research area or project objectives. Apply critical thinking and problem-solving abilities to overcome research obstacles, troubleshoot experimental issues, and adapt methodologies to achieve research goals effectively.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO4: Conduct research with integrity, adhering to ethical principles, responsible conduct guidelines, and regulatory requirements to ensure the ethical conduct of research and reporting of findings.
CO5: Effectively communicate research findings, methodology, and implications to both technical and non-technical audiences through written reports, oral presentations, and visual aids. Collaborate with peers, advisors, and stakeholders to leverage diverse perspectives, resources, and expertise, demonstrating

leadership qualities in coordinating research efforts and driving progress toward project objectives.

PO6: Communication, Collaboration, and Leadership

CO5: Collaborate with peers, advisors, and stakeholders to leverage diverse perspectives, resources, and expertise, demonstrating leadership qualities in coordinating research efforts and driving progress toward project objectives.

CO6: Utilize digital tools, software platforms, and technological resources to support research activities, data analysis, and knowledge dissemination throughout the project lifecycle.

PO7: Digital Proficiency and Technological Skills

CO6: Utilize digital tools, software platforms, and technological resources to support research activities, data analysis, and knowledge dissemination throughout the project lifecycle.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO4: Conduct research with integrity, adhering to ethical principles, responsible conduct guidelines, and regulatory requirements to ensure the ethical conduct of research and reporting of findings.

CO7: Take ownership of the research project, demonstrating autonomy in decision-making, project management, and resource allocation to ensure progress and timely completion. Assume responsibility for project outcomes, including the quality of research outputs, adherence to timelines, and effective utilization of resources, while being accountable to stakeholders, collaborators, and regulatory bodies.

PO10: Autonomy, Responsibility, and Accountability

CO7: Take ownership of the research project, demonstrating autonomy in decision-making, project management, and resource allocation to ensure progress and timely completion. Assume responsibility for project outcomes, including the quality of research outputs, adherence to timelines, and effective utilization of resources, while being accountable to stakeholders, collaborators, and regulatory bodies.