M. Sc. - II Inorganic Chemistry

Semester- IV

PSCHI 241: Heterogeneous Catalysis and Inorganic polymers (48L+12T) (4Credit)

Learning Objectives:

1) Students know the approaches and various theories in heterogeneous catalysis.
2) Students understand the concept of heterogeneous catalysis.
3) To understand Descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.
4) Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique.
5) To understand Heterogeneous catalysis used in Intercalation compounds, Perovskites related oxides, Oxides with Scheelite structure.
6) To get knowledge about inorganic polymers.

Learning Outcome:

1) Students understand descriptive chemistry of inorganic polymer.
2) Student will be able to classify inorganic polymers.
3) Student will be able to classify porous materials.
4) Student able to understand concept of absorption and adsorption.
5) Student should be able to characterize zeolite by using different methods.
6) Student should be able to understand concepts of chemisorption, physisorption.
7) Students identify the metal clusters.
8) Students understand the concept of heteropolar inorganic polymer.

Section I 24L

Descriptive chemistry of Heterogeneous Catalysis 6L

1. 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 ofhydrocarbons, Different typesof reactors.

2. Zeolite compounds and heterogenous catalysis 12L

a) Introduction to meso-porous & micro porous materials: classification into micro meso and macroporous material the origin pore and its significance.

b) Zeolites-Definition, types, natural and synthetics zeolites and aluminosilicate, primary and secondary building blocks,final framework structure, Lowensteine rule, sodalite and other structure,nomenclature, example of small, medium, large and extra-large pore zeolites general properties and application of molecular sieve.

c) Characterization of Zeolites:
XRD, SEM and other spectral techniques, FT-IR, Solid state NMR, Surface area by BET method, pore volume& pore structure, origin of Bronsted acidity & basicity in zeolites.

3. Heterogeneous catalysis using intercalation compounds. 2L

General aspects of interstial compounds of graphite, structural aspects of graphite intercalation compound, physical and chemical properties, catalytic reactions.

4. Heterogenous catalysis using Pervoskite related oxides 4L

Solid state properties of pervoskites like oxides, relation of solid state and catalytic properties of pervoskites.

Section II 24L

1. Inorganic polymers:10L

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.

3. Metal clusters: metal metals bonds, framework bonding in a metal cluster, synthesis of metal Clusters 2L

4. Photo catalysis using semiconducting oxides: 6L

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

5. Immobilization of transition metal complex catalyst on Inorganic support:6L

Anchored catalysts. Industrial applications of heterogeneous catalysis.

Reference Books:

1. Heterogeneous catalysts – principles and applications – G. C. Bond
2. Introduction to Zeolite Science and Practice – H. Van Bekkum, E. M. Flanigen, P. A.Jacobs and J. C. Jahnson, Elsevier, Amsterdam, 2001.
3. Catalysis – Principles and applications – B. Vishwanath, S. Shivshankar and A.V.Ramaswamy, Narosa Publishing House, New Delhi, 2004.
4. Advanced Materials in Catalysis – J. J. Burton, R. L. Garten, Academic Press, New York, 1977.
5. N.H.Ray, Inorganic Polymers academic press(1978)
6. 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 17

Mapping of Program Outcomes with Course Outcomes

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

Course: Heterogeneous Catalysis & inorganic Polymers **Course Code**: PSCHI:241

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
CO1	3	3		2	2	2		3	3
CO2	3	2		2	1				
CO3	3	3			1				
CO4	3								
CO5	3								
CO6									

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students understand the concept of heterogeneous catalysis.

CO2: To understand Descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO3: To understand Heterogeneous catalysis used in Intercalation compounds, Perovskites related oxides, Oxides with Scheelite structure.

CO4: Students understand descriptive chemistry of inorganic polymer.

CO5: Student will be able to classify inorganic polymers.

PO2: Critical Thinking and Problem Solving

CO1: Students knows the approaches and various theories in heterogeneous catalysis

CO2: Students identify the metal clusters.

CO3: Student should be able to characterize zeolite by using different methods.

PO4: Research relatated skills and Scientific temper

CO1: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique

CO2: Students understand the synthesis of heteropolar inorganic polymer

PO5: Trans-disciplinary Knowledge

CO1: Students will able to apply their knowledge in various fields

CO2: Student able to understand concept of absorption and adsorption.

CO3: Student should be able to understand concepts of chemisorption, physisorption.

PO6: Personal and Professional Competence

CO1: Students Define/memories the terms related to-applications of nanomaterials,band theory, defect in crystal structures, some properties of nanomaterials, synthesis of nanomaterials.

PO8: Environment and sustainability

CO1: To get knowledge about inorganic polymers.

PO9: Self-directed and Life-long Learning

CO1**:** Student understand the applications of heterogeneous catalysis in research field

PSCHI-242: Material science I: Inorganicmaterials and solid state chemistry (48L+12T) (4Credit)

Learning Objectives:

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

Learning Outcomes:

1) Student should understand the types of crystal defects.
2) Student should understand the magnetic materials.
3) Student will be able to understand the applications of semiconducting devices.
4) Student will be able to understand photonic devices.
5) Student should understand the concept of luminescence.
6) Student should understand method of finding type of spinel of given compound.
7) Student will understand concept of conductivity, types of conductors and their applications.
8) Student should understand superconductivity, types, and applications.

Section I 24L

1.Structure of solids and crystal defect 12L

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

b) 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.

2. Magnetic materials: Magnetism in solids, hysteresis loop and their classification, soft andhard ferrites, spinels, garnets, applications of magnetic materials. 4L

3. Electronic and optical materials 8L

a) Electronic materials and applications

Conductivity: conductors, insulators, semiconductors, superconductors, temperature dependent conductivity.

Applications of semiconducting devices: metal-metal junction i.e., Peltier effect and seebeckeffect, diodes, transistors, metal-semiconductor junction

b) Optical materials and their properties

Photonic devices, photoluminescence, crystalline laser.

Section II 24L

4. Superconducting materials 6L

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.

5. Ceramic materials 6L

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

6. Composite materials 6L

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

7. Biomaterials 6L

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

Reference books:

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 Vlack(5^{th} edition, Wiley 1988)

Mapping of Program Outcomes with Course Outcomes

Class: M.Sc. (Sem III) **Subject**: Chemistry
Course: Material Science I: Solid state chemistry **Course Code**: PSCHI: 242
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
CO1	3	3		2	2	2		3	3
CO2	3	3		2	2				2
CO3	3	2							3
CO4	3								
CO5									
CO6									

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: To get knowledge about structure of solid and crystal defects.
CO2: To understand Magnetic materials, types, and applications.
CO3: To study about electronic and optical materials, Superconducting materials, ceramic materials, composite materials, Biomaterials and Meta materials
CO4: To find spinel structure of given metal ferrites.

PO2: Critical Thinking and Problem Solving

CO1: To differentiate between magnetic materials.
CO2: Student should understand method of finding type of spinel of given compound.
CO3: To identify defect in solid.

PO4: Research relatated skills and Scientific temper

CO1: Student should understand the types of crystal defects.
CO2: Students understand the synthesis of heteropolar inorganic polymer

PO5: Trans-disciplinary Knowledge

CO1: Student should understand superconductivity, types, and applications.
CO2: Student will understand concept of conductivity, types of conductors and their Applications

PO6: Personal and Professional Competence

CO1: Student will be able to understand the applications of semiconducting devices.

PO8: Environment and sustainability

CO1: To understand the optical materials and their properties.

PO9: Self-directed and Life-long Learning

CO1: Student should understand the magnetic materials.
CO2: Student will be able to understand photonic devices
CO3: Student should understand the concept of luminescence.

PSCHI-243: Materials Science-II: Nanomaterials
(48L+12T) (4Credit)

Learning Objectives:

1) understand the concept of Nanomaterials.
2) understand the how to synthesize nanomaterials by using various methods.
3) understand properties of nanomaterials and their structural determination by using instrumental techniques.
4) understand nano porous materials.
5) To get knowledge about application of nanotechnology in medicinal chemistry and biology.

Learning Outcomes:

1) Student will be understanding the nanotechnology.
2) Student should understand different method of synthesis of nanomaterials.
3) Student will be able to understand the concept of oxide nanoparticles.
4) Student should understand the optical and chemical properties of nanoparticles.
5) Student should understand the methods used for structural determination of nanoparticles.
6) Students get knowledge about photochemistry of nanomaterials.
7) Students get knowledge of applications of nanomaterials in medical field.
8) Students get knowledge of biological applications of nanomaterials.

1. Introduction to Nanomaterials 2L

2. Synthesis of nanomaterials 14L

(Methods such as solvothermal, sonochemical, CVD, Arc discharge method,Hydrothermal, Co-precipitation, Microwave, Sol gel method, Ball milling)

a. Oxide Nanoparticles
b. Zero valent metal nanoparticles
c. Zero valent bimetallic nanoparticles
d. Semiconducting sulphides&Selenides, Nanotubes, nanowires.

3. Properties and Structures 10L

a. Optical and electrical properties
b. Electronic structure & spectral properties of semiconductor Nanocrystals.
c. Nanotubes, synthesis, Properties and Application.

4. Structural determination, application, morphology 14L

Raman spectroscopy, XRD, SEM, TEM, HRTEM, ESEM, Cryo-SEM, AFM, Scanning tunneling microscopy

5. Nano porous materials 2L

6. Application of nanotechnology in medicinal chemistry, Biological Applications& Application As sensor. 6L

Reference Books:

1. The Chemistry of Nanomaterials edited by C.N.R.Rao, A.Muller, A.K.Cheetham Wiley-VCH Verlag GmbH & co. Volumes 1&2
2. WTEC Panel Report on Nanostructure Science and Technology edited by Richard Siegel,Evelin Hu7M.C. RoCo—Kluwer Academic Publishers, Boston/London.
3. Nanomaterials by Dr. SulbhaKulkarni.
4. Nanotechnology, G. Timp; Springer, AIP Press, 2012.
5. Nanoscopic Materials – Size Dependent Phenomenon, E. Roduner, RSC Publishing 2006.
6. Nanochemistry – A Chemical Approach to Nanomaterials, G. A. Ozim, A. C. Arsenault, L. Cadematiri, RSC Publishing 2009.

Mapping of Program Outcomes with Course Outcomes

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

Course: Material science II: Nanomaterials **Course Code**: PSCHI:243

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
CO1	3	3		3	2	2		3	1
CO2	3	3		2					
CO3	3	2		3					
CO4	3								
CO5	3								
CO6	3								

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: understand the concept of Nanomaterials.
CO2: understand the how to synthesize nanomaterials by using various methods.
CO3: understand properties of nanomaterials and their structural determination by using instrumental techniques.
CO4: To understand nano porous materials.
CO5:Student should understand different method of synthesis of nanomaterials.
CO6:Student will be able to understand the concept of oxide nanoparticles.

PO2: Critical Thinking and Problem Solving

CO1: Students knows applications of nanoparticals in chemical reaction
CO2: Students methods of nanopartical synthesis
CO3: Student should be able to characterize nanoparticals by using different methods.

PO4: Research relatated skills and Scientific temper

CO1: To get knowledge about application of nanotechnology in medicinal chemistry and Biology.
CO2: Student should understand the methods used for structural determination of nanoparticles.
CO3: Students get knowledge of applications of nanomaterials in medical field.

PO5: Trans-disciplinary Knowledge

CO1: To get knowledge about application of nanotechnology in medicinal chemistry & biology

PO6: Personal and Professional Competence

CO1: Students Define/memories the terms related to-applications of nanomaterials,band theory, defect in crystal structures, some properties of nanomaterials, synthesis of nanomaterials.

PO8: Environment and sustainability

CO1: Students get knowledge of biological applications of nanomaterials.

PO9: Self-directed and Life-long Learning

CO1: Students get knowledge of applications of nanomaterials in medical field.

PSCHI-244: Inorganic applications in industrial and environmental chemistry(48L+12T) (4Credit)

Learning Objectives:

1) To understand introduction, Classifications and applications of Dyes and pigment.
2) To get knowledge about electrochemical applications.
3) To get knowledge about wastewater management technique.
4) To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.
5) To get knowledge about photographic products industry.
6) To get knowledge about methods of electrodeposition of various metals.

Learning Outcomes:

1) Student should understand the concept of dyes and pigments.
2) Students get knowledge about various types of dyes their types and applications.
3) Students can understand the photochemistry of zinc oxide and titanium dioxide.
4) Students understand various methods of wastewater treatment.
5) Students understand the concept of green chemistry.
6) Students should understand methods of heavy metal detection from wastewater.

Section I: Inorganic applications in industry 24L

1. Dyes and Pigments 12L

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.

2. Electrochemical applications 6L

Introduction, brief discussion on classical electrodeposition of metals.

3. Photographic Products Industry 6L

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

Section II: Environmental chemistry 24L

1.Introduction to wastewater analysis and wastewater engineering for biological treatment. 6L

2.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. 6L

3.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. 6L

4.Green Chemistry: Introduction designing a green synthesis basic principle of green chemistry, green chemistry in day-to-daylife, green chemistry in a sustainable development 6L

Reference books:

1. Handbook of industrial chemistry by K. H.Davis, F. S. Bernel, CBS Publishers Bangalore
2. Environmental chemistry by Girard
3. Textbook of environmental chemistry by Balram Pani
4. Insight into specialty inorganic chemicals by David Thomson
5. Environmental chemistry by Stanley Manahan 10^{th} edition.
6. New trends in a green chemistry(2^{nd} edition) – V.K.Ahluwalia and M.Kidwai (Anamaya Publishers), 2007

Mapping of Program Outcomes with Course Outcomes

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

Course: Industrial applications of inorganic chemistry and environmental chemistry **Course Code**: PSCHI:244

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
CO1	3	3		3	2	3		3	2
CO2	3	2		2	1			2	
CO3	3	3						2	
CO4								3	
CO5									
CO6									

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: To understand introduction, Classifications and applications of Dyes and pigment.
CO2: To get knowledge about photographic products industry.
CO3: Students understand the concept of green chemistry.

PO2: Critical Thinking and Problem Solving

CO1: To get knowledge about methods of electrodeposition of various metals.
CO2: Student should understand the applications of dyes and pigments.
CO3: Students can understand the photochemistry of zinc oxide and titanium dioxide.

PO4: Research relatated skills and Scientific temper

CO1: To get knowledge about electrochemical applications
CO2: Students get knowledge about various types of dyes their types and applications

PO5: Trans-disciplinary Knowledge

CO1: Students will able to apply their knowledge in various fields
CO2: Student understands detection of BOD & COD from waste water.

PO6: Personal and Professional Competence

CO1: Student understand waste water analysis

PO8: Environment and sustainability

CO1: To get knowledge about wastewater management technique
CO2: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.
CO3: Students understand various methods of wastewater treatment.
CO4: Students should understand methods of heavy metal detection from wastewater.

PO9: Self-directed and Life-long Learning

CO1: To get knowledge about wastewater management technique

PSCHI-245: Extended practical in inorganic chemistry
(4 Credits)

Learning Objectives:

1) To understand Methods of inorganic estimations.
2) To understand Methods of Inorganic preparations.
3) To understand the methods of characterization of metal complexes
4) To interpret given IR spectrum
5) To interpret given XRD spectrum
6) To understand handling of UV, IR magnetic susceptibility.

Learning Outcomes:

1) Students will be able to Prepare solution of required concentration and handle the laboratory equipment.
2) Student able to calculate the quantity from observation of the experiment and interpret the result.
3) Perform calculations and discuss results and write conclusion of the experiment.
4) To interpret given spectrum of IR, XRD, NMR and ESR.
5) Student should perform experiment accurately and able to perform calculations.
6) To understand method to perform case study.

A. 1) Preparation and purity of complexes (any 2 metal)

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.(any 2)

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

C. Case Study

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

Mapping of Program Outcomes with Course Outcomes

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

Course: Extended practical in inorganic chemistry **Course Code**: PSCHI: 245

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
CO1	3	3		3	2	3			3
CO2	3	3		2	3				
CO3	3	3		3					
CO4	3								
CO5									
CO6									

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: To understand Methods of inorganic estimations
CO2: To understand Methods of Inorganic preparations.
CO3: To understand the methods of characterization of metal complexes
CO4: To understand handling of UV, IR magnetic susceptibility

PO2: Critical Thinking and Problem Solving

CO1: To interpret given IR spectrum
CO2: To interpret given XRD spectrum
CO3: Student should perform experiment accurately and able to perform calculations.

PO4: Research related skills and Scientific temper

CO1: Perform calculations and discuss results and write conclusion of the experiment.

CO2: To interpret given spectrum of IR, XRD, NMR and ESR
CO3: Student should perform experiment accurately and able to perform calculations.

PO5: Trans-disciplinary Knowledge

CO1: To understand method to perform case study
CO2: Students will be able to prepare solution of required concentration and handle the laboratory equipment.

PO6: Personal and Professional Competence

CO1: Student understand Methods of inorganic estimations.

PO9: Self-directed and Life-long Learning

CO1 : Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow

PSCHI-246: Project work
(4Credit)

Learning Objectives:

1) To understand Research methodology
2) To understand Methods of Inorganic preparations.
3) To understand the methods of characterization of metal complexes.
4) To enhance research attitude.
5) To enhance critical thinking of students.

Learning Outcomes:

1) To enhance thinking ability of students
2) To demonstrate skill and knowledge of current information
3) Perform calculations and discuss results and write conclusion of the experiment.
4) To interpret IR, XRD, NMR and ESR spectrum of their project work.
5) Student should perform experiment accurately and able to perform calculations.
6) Students able to apply fundamental and disciplinary concepts.
7) Student able to calculate the quantity from observation of the experiment and interpret the result.

This is mandatory for every student to undertake the project work on selected area of study under the guidance of project coordinator. Student must carry out entire experimental work within the stipulated time and present it briefly in the form of the dissertation at the time evaluations.

Mapping of Program Outcomes with Course Outcomes

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

Course: Project Work **Course Code**: PSCHI: 246

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
CO1	3	3		3	3	3			3
CO2	3	3		3					
CO3	3			2					
CO4	3								
CO5									
CO6									

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: To understand Research methodology
CO2: To understand Methods of Inorganic preparations.
CO3: To understand the methods of characterization of metal complexes
CO4: To understand handling of UV, IR magnetic susceptibility

PO2: Critical Thinking and Problem Solving

CO1: To interpret given IR spectrum
CO2: To interpret given XRD spectrum
CO3: Student should perform experiment accurately and able to perform calculations.

PO4: Research related skills and Scientific temper

CO1: To understand the methods of characterization of metal complexes.
CO2: To interpret given spectrum of IR, XRD, NMR and ESR
CO3: To demonstrate skill and knowledge of current information

PO5: Trans-disciplinary Knowledge

CO1: To enhance research attitude.

PO6: Personal and Professional Competence

CO1: Student understand Methods of inorganic estimations.

PO9: Self-directed and Life-long Learning

CO1 : Student enhance to demonstration ability in a authentic context and make consider decision about which possibilities to follow