



Anekant Education Society's

# Tuljaram Chaturchand College of Arts, Science, Commerce, Baramati

(Autonomous)

## DEPARTMENT OF CHEMISTRY

(Faculty of Science and Technology)

### Two Year MSc Degree Program Chemistry

#### MSc II Inorganic Chemistry

(2022 Pattern)

#### Choice Based Credit System Structure and Syllabus

(To be implemented from June 2022)



**M. Sc. - II Inorganic Chemistry**  
**Semester- IV**

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

**Course 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.

**Course Outcome:**

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

CO1: To get knowledge about descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO2: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique

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

CO4: To get knowledge about inorganic polymers.

CO5: Student should be able to characterize zeolite by using different methods.

CO6: Student should be able to understand concepts of chemisorption, physisorption.

CO7: Students apply their knowledge to find out applications of inorganic polymers involve in industry.

**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 of hydrocarbons, Different types of 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 synthetic zeolites and alumina silicate, 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.



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

**4. Heterogeneous 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 metal 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



Choice Based Credit System Syllabus (2022 Pattern)

**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary Knowledge**

CO1: to get knowledge about descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO2: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique

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

CO4: To get knowledge about inorganic polymers.

CO5: Student should be able to characterize zeolite by using different methods.

CO6: Student should be able to understand concepts of chemisorption, physisorption.

CO7: Student apply their knowledge to find out applications of inorganic polymers involve in industry.

**PO2: Critical Thinking and Problem Solving**

CO2: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique

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

**PO3: Social competence**

CO1: to get knowledge about descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO2: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique



**PO4: Research related skills and Scientific temper**

CO1: to get knowledge about descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO2: Get knowledge about Zeolite compounds, Characterization of Zeolite by XRD, SEM, FT-IR technique

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

**PO5: Trans-disciplinary Knowledge**

CO1: to get knowledge about descriptive chemistry of heterogeneous catalysis it includes adsorption, absorption phenomenon, Types of reactors, catalysis by supported & unsupported bimetals.

CO5: Student should be able to characterize zeolite by using different methods.

CO6: 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**

CO5: To get knowledge about inorganic polymers.

**PO9: Self-directed and Life-long Learning**

CO6: Student understand the applications of heterogeneous catalysis in research field



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

### Course 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.

### Course Outcomes:

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

CO1: To get knowledge about structure of solid and crystal defects.

CO2: students differentiate the magnetic materials according to their type.

CO3: To get knowledge about electronic and optical materials, Superconducting materials, ceramic materials, composite materials, Biomaterials and Meta materials.

CO4: Student should understand the concept of luminescence.

CO5: Student should understand method of finding type of spinel of given compound.

CO6: Student will understand concept of conductivity, types of conductors and their applications.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry.

## 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, perovskite 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 and hard 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 seebeck effect, 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 T<sub>c</sub> superconductivity, Low T<sub>c</sub> 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<sup>th</sup> edition, Wiley 1988)



Choice Based Credit System Syllabus (2022 Pattern)  
**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary Knowledge**

CO1: To get knowledge about structure of solid and crystal defects.

CO2: students differentiate the magnetic materials according to their type.

CO3: To get knowledge about electronic and optical materials, Superconducting materials, ceramic materials, composite materials, Biomaterials and Meta materials.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry

**PO2: Critical Thinking and Problem Solving**

CO2: students differentiate the magnetic materials according to their type.

CO4: Student should understand the concept of luminescence.

CO5: Student should understand method of finding type of spinel of given compound.

CO6: Student will understand concept of conductivity, types of conductors and their applications.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry

**PO4: Research related skills and Scientific temper**

CO6: Student will understand concept of conductivity, types of conductors and their applications.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry

**PO5: Trans-disciplinary Knowledge**

CO6: Student will understand concept of conductivity, types of conductors and their applications.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry





**PO6: Personal and Professional Competence**

CO1: To get knowledge about structure of solid and crystal defects.

CO2: students differentiate the magnetic materials according to their type.

CO3: To get knowledge about electronic and optical materials, Superconducting materials, ceramic materials, composite materials, Biomaterials and Meta materials.

**PO9: Self-directed and Life-long Learning**

CO4: Student should understand the concept of luminescence.

CO6: Student will understand concept of conductivity, types of conductors and their applications.

CO7: Students apply their knowledge about superconducting & semiconducting materials for making electronic devices in industry



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

### Course 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.

### Course Outcomes:

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

CO1: get knowledge about concept of Nanomaterials.

CO2: apply their knowledge & does application of nanoparticles in their research work.

CO3: get knowledge about properties of nanomaterials and their structural determination by using instrumental techniques.

CO4: identify nanoporous materials & their applications.

CO5: use their knowledge for nanoparticle synthesis & does application of other fields.

CO6: find the method for characterization of nanoparticle the concept of oxide nanoparticles.

CO7: Student able to find green synthesis route of nanoparticles

<b>1. Introduction to Nanomaterials</b>	2L
<b>2. Synthesis of nanomaterials</b> (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.	14L
<b>3. Properties and Structures</b> a. Optical and electrical properties b. Electronic structure & spectral properties of semiconductor Nanocrystals. c. Nanotubes, synthesis, Properties and Application.	10L
<b>4. Structural determination, application, morphology</b> Raman spectroscopy, XRD, SEM, TEM, HRTEM, ESEM, Cryo-SEM, AFM, Scanning tunneling microscopy	14L
5. Nano porous materials	2L
6. Application of nanotechnology in medicinal chemistry, Biological Applications& Application Assensor.	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.



Choice Based Credit System Syllabus (2022 Pattern)

**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary Knowledge**

CO1: get knowledge about concept of Nanomaterials.

CO2: apply their knowledge & does application of nanoparticles in their research work.

CO3: get knowledge about properties of nanomaterials and their structural determination by using instrumental techniques.

CO5: use their knowledge for nanoparticle synthesis & does application of other fields.

**PO2: Critical Thinking and Problem Solving**

CO2: apply their knowledge & does application of nanoparticles in their research work.

CO4: identify nanoporous materials & their applications.

CO6: find the method for characterization of nanoparticle the concept of oxide nanoparticles.

CO7: Student able to find green synthesis route of nanoparticles

**PO4: Research related skills and Scientific temper**

CO2: apply their knowledge & does application of nanoparticles in their research work.

CO5: use their knowledge for nanoparticle synthesis & does application of other fields.

CO6: find the method for characterization of nanoparticle the concept of oxide nanoparticles.

CO7: Student able to find green synthesis route of nanoparticles

**PO5: Trans-disciplinary Knowledge**

CO2: apply their knowledge & does application of nanoparticles in their research work.

CO4: identify nanoporous materials & their applications.

CO5: use their knowledge for nanoparticle synthesis & does application of other fields.

**PO6: Personal and Professional Competence**

CO1: get knowledge about concept of Nanomaterials.

CO2: apply their knowledge & does application of nanoparticles in their research work.



**PO7: Effective citizenship and ethics**

CO7: Student able to find green synthesis route of nanoparticles

**PO8: Environment and sustainability**

CO7: Student able to find green synthesis route of nanoparticles.

**PO9: Self-directed and Life-long Learning**

CO7: Student able to find green synthesis route of nanoparticles.



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

### Course 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.

### Course Outcomes:

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

- CO1: will develop critical thinking skills to apply their knowledge of environmental chemistry in real world scenarios, considering interdisciplinary perspectives & making informative decisions.
- CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole
- CO3: will gain knowledge about chemical components present in water.
- CO4: To understand methods of Bioremediations.
- CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.
- CO6: Students should understand methods of heavy metal detection from wastewater.
- CO7: Students get knowledge about various types of dyes their types and applications.

### 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<sub>2</sub> 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-day life, 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<sup>th</sup> edition.
6. New trends in a green chemistry( 2<sup>nd</sup> edition) – V.K. Ahluwalia and M. Kidwai (Anamaya Publishers), 2007



Choice Based Credit System Syllabus (2022 Pattern)

**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary Knowledge**

CO1: will develop critical thinking skills to apply their knowledge of environmental chemistry nreal world scenarios, considering interdisciplinary perspectives & making informative decisions.

CO3: will gain knowledge about chemical components present in water.

CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.

CO7: Students get knowledge about various types of dyes their types and applications.

**PO2: Critical Thinking and Problem Solving**

CO1: will develop critical thinking skills to apply their knowledge of environmental chemistry Inreal world scenarios, considering interdisciplinary perspectives & making informative decisions.

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.

CO6: Students should understand methods of heavy metal detection from wastewater.

**PO4: Research related skills and Scientific temper**

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.

CO6: Students should understand methods of heavy metal detection from wastewater.

CO7: Students get knowledge about various types of dyes their types and applications.





**PO5: Trans-disciplinary Knowledge**

CO1: will develop critical thinking skills to apply their knowledge of environmental chemistry in real world scenarios, considering interdisciplinary perspectives & making informative decisions

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO3: will gain knowledge about chemical components present in water.

**PO6: Personal and Professional Competence**

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO3: will gain knowledge about chemical components present in water.

CO4: To understand methods of Bioremediations.

**PO7: Effective citizenship and ethics**

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO3: will gain knowledge about chemical components present in water.

CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.

**PO8: Environment and sustainability**

CO1: will develop critical thinking skills to apply their knowledge of environmental chemistry in real world scenarios, considering interdisciplinary perspectives & making informative decisions.

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO3: will gain knowledge about chemical components present in water.

CO5: To study about bioaccumulation of toxic metal, energy sources for the future – fuel cells.

CO6: Students should understand methods of heavy metal detection from wastewater.

CO7: Students get knowledge about various types of dyes their types and applications.

**PO9: Self-directed and Life-long Learning**

CO2: learn to evaluate the impact of chemical pollutants on ecosystems, human health & the environment as whole

CO5: To study about bioaccumulation of toxic metal, energy sources for the future fuel cells.

CO6: Students should understand methods of heavy metal detection from wastewater.



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

### Course 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.

### 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: gain hands on experience in using various laboratory techniques .

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

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

CO6: will develop critical thinking skills, apply their knowledge to troubleshoot experiments.

CO7: Student understand research ethics.

### 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.)



Choice Based Credit System Syllabus (2022 Pattern)  
**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary 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.

CO3: gain hands on experience in using various laboratory techniques .

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

**PO2: Critical Thinking and Problem Solving**

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.

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

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

CO6: will develop critical thinking skills, apply their knowledge to troubleshoot experiments.

**PO4: Research related skills and Scientific temper**

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

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

CO6: will develop critical thinking skills, apply their knowledge to troubleshoot experiments.

CO7: Student understand research ethics.

**PO5: Trans-disciplinary Knowledge**

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



CO7: Student understand research ethics.

**PO6: Personal and Professional Competence**

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.

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

CO7: Student understand research ethics.

**PO7: Effective citizenship and ethics**

CO7: Student understand research ethics.

**PO9: Self-directed and Life-long Learning**

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: gain hands on experience in using various laboratory techniques .

CO4: learn to observe & interpret chemical reactions involving inorganic compounds, including formation of precipitate and colour change.

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

CO6: will develop critical thinking skills, apply their knowledge to troubleshoot experiments.



## PSCHI-246: Project work (4Credit)

### Course 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.

### Course Outcomes:

- CO1: To enhance & oral communications skills.
- CO2: To learn effectively manage their time & resources to complete their project within Given time frame
- CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.
- CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.
- CO5: gain experience in designing experiments to investigate specific research questions.
- CO6: develop problem solving to execute their project
- CO7: develop problem solving & critical thinking skills by encountering challenges or Obstacles during their projects.

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.



Choice Based Credit System Syllabus (2022 Pattern)  
**Mapping of Program Outcomes with Course Outcomes**

**Class:** M.Sc. (Sem IV)

**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

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

**Justification for the mapping**

**PO1: Disciplinary Knowledge**

CO1: To enhance & oral communications skills.

CO2: To learn effectively manage their time & resources to complete their project within given time frame.

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO5: gain experience in designing experiments to investigate specific research questions.

CO6: develop problem solving to execute their project

CO7: develop problem solving & critical thinking skills by encountering challenges or obstacles during their projects.

**PO2: Critical Thinking and Problem Solving**

CO2: To learn effectively manage their time & resources to complete their project within given time frame

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO6: develop problem solving to execute their project

CO7: develop problem solving & critical thinking skills by encountering challenges or obstacles during their projects.

**PO4: Research related skills and Scientific temper**

CO2: To learn effectively manage their time & resources to complete their project within given time frame

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO5: gain experience in designing experiments to investigate specific research questions.

CO6: develop problem solving to execute their project



CO7: develop problem solving & critical thinking skills by encountering challenges or obstacles during their projects.

**PO5: Trans-disciplinary Knowledge**

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO5: gain experience in designing experiments to investigate specific research questions.

CO7: develop problem solving & critical thinking skills by encountering challenges or obstacles during their projects.

**PO6: Personal and Professional Competence**

CO1: To enhance & oral communications skills .

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO6: develop problem solving to execute their project

CO7: develop problem solving & critical thinking skills by encountering challenges or obstacles during their projects.

**PO7: Effective citizenship and ethics**

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO5: gain experience in designing experiments to investigate specific research questions.

**PO8: Environment and sustainability**

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

**PO9: Self-directed and Life-long Learning**

CO3: develop research skills by effectively searching for & evaluating relevant scientific literature related to their project topics.

CO4: To interpret IR, XRD, NMR and ESR spectrum of their project work.

CO5: gain experience in designing experiments to investigate specific research questions.

