SWAMI RAMANAND TEERTH
MARATHWADA UNIVERSITY, NANDED - 431 606

Two Years Post Graduate Degree Program in Chemistry

(Faculty of Science and Technology)

Revised Syllabi as per NEP-2020 for

M.Sc. Second Year

INORGANIC CHEMISTRY

(For Affiliated Colleges)

To be implemented from

Academic year 2024 - 2025

Framed by

BOARD OF STUDIES IN CHEMISTRY

S.R.T.M. University, Nanded - 431 606

Syllabus for M. Sc. Inorganic Chemistry, Second Year

Semester – III

As Per National Education Policy- 2020

To be implemented from

Academic Year 2024-2025

National Education Policy 2020

M.Sc. Inorganic Chemistry, II Year (Semester - III)

Major Core Theory Course

Course Code – SCHECT1501

Title of the Course: Advanced Spectroscopic Methods

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- Students are acquainted with various spectroscopic techniques to elucidate the known and unknown organic molecules.
- Students are familiar with the ultra-violet and visible spectroscopy by determining the absorption maximum of various dienes, enones and aromatic organic compounds.
- Student develops the detail knowledge to get the different peaks of functional groups in organic molecules by infra-red spectroscopy.
- Students understand the importance and applications of proton magnetic resonance spectroscopy for determination of structure of unknown organic compounds.
- Students are recognizable with CMR to authenticate the position of carbon atom in organic molecules.
- Students identified the structure of compounds by fragmentation of various classes of organic molecules.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**UV-VIS AND IR SPECTROSCOPY:**	**17**
	1.1	**UV-Vis Spectroscopy:** Fieser-Woodward rules for conjugated dienes and carbonyl compounds, Fieser-Kuhn rules for polyenes. UV spectra of aromatic compounds and heteroaromatic compounds. Calculation of max for the benzene derivatives (R-C6H4-Co-G) by A. I. Scott emperical rules.	
	1.2	**IR spectroscopy:** Recapitulation, Characteristic vibration frequencies of Alkanes, Alkenes, Alkynes, Aromatic compounds, Alcohols, Ethers, Phenols and Amines. Detailed study of vibrational frequencies of carbonyl compounds Ketones, Aldehydes, Esters, Amides, Acids, Anhydride, Lactose, Lactams and Conjugated Carbonyl compounds. Factors affecting group frequencies: overtones, combination bands and Fermi-resonance. FITR and sampling techniques.	
2.0		**Module 2: ^{1}H NMR AND ^{13}C NMR SPECTROSCOPY:**	
	2.1	General introduction and definitions, Chemical shift, Spin-spin interaction, Shielding mechanism of measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehyde and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides and mercapto). Factors affecting chemical shift. Deuterium exchange. Spin-spin coupling, factors	

Course outcomes:

1. Know the use electronic spectroscopy to determine absorption maximum in dienes, enones and aromatic compounds.
2. Know the applications of IR spectroscopy for functional group determination.
3. Learn the structure elucidation of organic compounds by PMR spectroscopy.
4. Gathering basic knowledge to know the position of carbon in carbon compounds.
5. Recognize the molecular mass of the organic molecule by fragmentation pattern.
6. Know the complete structure of compounds using UV, IR, PMR, CMR and Mass spectroscopic methods.

Reference Books:

1. Spectroscopic Identification of Organic Compounds, R. M. Silverstern, G. C.Bassler and T. C. Morril.
2. Introduction to NMR spectroscopy, R. J. Abraham, J. Fisher and P. Loftus.
3. Application of spectroscopy of organic compounds, J. R. Dyer.
4. Spectroscopy of organic compounds, P. S. Kalsi.
5. Organic Spectroscopy, William Kamp.
6. Organic Chemistry, R. T. Morrison and R. N. Boyd.
7. Practical NMR spectroscopy, M. L. Martin, J. J. Delpench and G. J. Martin.
8. Spectroscopic methods in organic Chemistry, D. H. William, I. Fleming.
9. Fundamentals of Molecular spectroscopy, C.N.Banwel.
10. A Handbook of Spectroscopic Data of Chemistry, B. D. Mistry.
11. Elementary Organic Spectroscopy, Y. R. Sharma.
12. Organic Radicals by Chuanyi Wang, Abdelkader Labidi and Eric Lichtfouse
13. https://pubs.acs.org/doi/abs/10.1021/cr400056a

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M.Sc. Inorganic Chemistry, II Year (Semester - III)

Major Core Theory Course

Course Code – SCHECT1502

Title of the Course: Organometallics and Homogeneous Catalysis

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- Highlight organometallics, conditions and its synthesis.
- Applying the knowledge of structure, bonding and reactivity of transition metals, rare metals, organometallics.
- To cover important industrial processes and to provide details about the reaction conditions, mechanisms, and synthetic applications.

Curriculum Details: SCHECT1502: Organometallics and Homogeneous Catalysis

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Module-I: ORGANOMETALLIC CHEMISTRY**	**12**
	1.1	Introduction, Classification, Nomenclature, 18 electron rule and their stability.	
	1.2	Synthesis and properties of organometallic compounds with i) carbonyl ii) Phosphine iii) Nitrosyl ligand.	
	1.3	Alkyls and Aryls, Stability of transition metal alkyls.	
	1.4	General methods of preparation of transition metal alkyls.	
	1.5	General characteristics of transition metal alkyls and aryls.	
2.0		**MODULE-II: COMPOUND OF TRANSITION METAL CARBON MULTIPLE BONDS, π COMPLEXES**	**12**
	2.1	Introduction, Transition metal carbene complexes, Classification.	
	2.2	Fischer carbene complexes, Schrock carbene complexes.	
	2.3	Transition metal alkylidyne complexes.	
	2.4	Complexes of Transition metal with Alkene, Alkyne, Allyl, Butadiene, Cyclobutadiene, Cyclopentadienyl, Arene and Trienyl moieties.	

Course outcomes:

1. Recollect the principles of electronic structure, bonding, and reactivity of coordination complexes.
2. Understand the concept of synthesis and stability of transition metal organometallic complexes.
3. Develop the possible catalytic pathways leading to desired products.
4. Apply the principles of transition metal coordination complexes in understanding functions of biological systems.
5. To feel the sense of inorganic compounds which exhibit various applications.

Reference Books:

1. Organometallic chemistry of transition metal – R.H. Carbetre , John Wiley.
2. Organometallic Chemistry – R.C. Mehrotra A. Singh – New age International.
3. Metalloorganic chemistry – A. J. Pearson – Wiley
4. Principles and Applications of organotransitions metal chemistry, J.P. Collman, L.S. Hagsdus J.R. Norton & R.G. Finke – University science book.
5. Organometallic Compounds, Inderjeet Kumar – Pragati Prakashan

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M.Sc. Inorganic Chemistry, II Year (Semester - III)

Major Core Theory Course

Course Code – SCHECT1503

Title of the Course: Nano Chemistry

[No. of Credits: 2 Credit] **[Total 30 Lectures]**

Course objectives:

- Understanding different types of nanomaterials, syntheses and characterization.
- Applying the knowledge of nanomaterials in science and technology.

Curriculum Details: SCHECT1503: Nano Chemistry

Module No.	UnitNo.	Topic	Hrs. Required to cover the

Course outcomes:

1. Define different types of nanomaterials based on dimensionality and structure.
2. Propose preparation methods for different nanomaterials.
3. Analyze nanomaterials using characterization techniques
4. Explain the structural and chemical properties of carbon-based nanomaterials.
5. Suggest nanomaterials for specific optical, electronic and energy storage applications
6. Relate structure of nanomaterials with their property

Reference Books:

1. G. Cao and Y. Wang (Ed), Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, 2nd Ed., World Scientific Publishers, 2011.
2. D. Vollath (Ed), Nanomaterials: An Introduction to Synthesis, Properties and Applications, 2nd Ed, Wiley VCH, 2013.
3. An introduction to nanomaterials and nanoscience- A. K. Das, M. Das – CBS publishers.

Course Code – SCHECE1501

Title of the Course: Chemistry of Materials

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- To learn, analyze and predict the properties of materials based on their atomic and molecular structures.
- To explore various methods for synthesizing materials with tailored properties for specific applications.
- Understanding the basic aspects of various structure types, polymeric, composite materials and materials synthesis.
- Correlating the structure and property of materials for transport, optical and dielectric properties.

Curriculum Details: SCHECE1501: Chemistry of Materials

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**STRUCTURE OF CRYSTALLINE SOLIDS, IMPERFECTIONS, MECHANICAL PROPERTIES OF METALS:**	**15**
	1.1	Crystal structure: Fundamentals concepts, Unit cells, Metallic structure, Crystallographic points, Directions and planes. Crystalline and non-crystalline materials: single crystal, poly crystalline materials, and non-crystalline solids.	
	1.2	Elastic deformation and Elastic properties of materials. Plastic deformation and their tensile properties.	
	1.3	Non- stoichiometry: Preliminary aspects, Defects in solids: Stoichiometric and nonstoichiometric defects - point defects - Schottky and Frenkel defects and properties.	
2.0		**MULTIPHASE MATERIALS:**	**15**
	2.1	Ferrous alloys, Fe-C phase transformation in ferrous alloys, stainless steel, properties of ferrous alloys and their application.	
	2.2	Non-ferrous alloys (compositions and applications of alloys of copper and Aluminium).	
	2.3	Fabrication of metals	
	2.4	Thermal processing of metals	
3.0		**CERAMICS AND COMPOSITES:**	**15**
	3.1	Ceramic structure and its Mechanical properties.	
	3.2	Types and Applications of ceramics.	
	3.3	Fabrication and processing of ceramics.	
	3.4	Particle Reinforced composites, Fibre Reinforced composites.	
	3.5	Structural composites.	
4.0		**MAGNETIC, OPTICAL AND DIELECTRIC PROPERTIES:**	
	4.1	Magnetic properties- Dia, para, ferro, anti-ferro and ferri magnetism – spinels and garnets measurements- magnetic moment and magnetic	

Course outcomes:

1) Correlating the structure and property of materials for transport, optical and dielectric properties.
2) Compare the different methods of materials synthesis on the pure phase formation of agiven compound.
3) Apply the concept of composite materials for various properties.
4) Unravel and interpret the reason behind the functioning of a given material.
5) Identify appropriate material for a given application in conducting, magnetic, optical and dielectric applications.
6) Fabricate a device using suitable material for practical application.

Reference Books:

1. Lesley E. Smart and Elaine A. Moore, Solid State Chemistry-An Introduction, 4th Ed., CRC Press, Taylor and Francis Group, 2012.
2. Richard J. D. Tilley, Understanding Solids: The Science of Materials, 2nd Ed., Wiley, 2013.
3. Chawla K Krishnan, Composite Materials –Science and Engineering, Springer, 2012.
4. Robert J. Young and Peter A. Lovell, Introduction to Polymers, 3rd Ed., CRC Press, 2011.
5. Material Science and Engineering An Introduction, William D, Callister- Wiley.

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M.Sc. Inorganic Chemistry, II Year (Semester - III)

Major Elective Theory Course

Course Code – SCHECE1501

Title of the Course: Photo Inorganic Chemistry

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- ❖ Applying the principles of photochemistry such as photosynthesis, solar energy conversion and medical photochemistry.
- ❖ Development of devices based on photochemistry for solar energy conversion and medical applications.

Curriculum Details: SCHECE1501: Photo Inorganic Chemistry

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**BASIC PHOTOCHEMISTRY:**	**15**
	1.1	Absorption, excitation, photochemical laws, quantum yield. Radiation, Absorption and emission for complexes with different ground state/ excited state for ML_6 complexes.	
	1.2	Potential energy function and energy levels for electronically transition of ML_6 complexes. Flash photolysis, stopped flow techniques. Energy dissipation by radiative and non-radiative processes, absorption spectra.	
	1.3	Frank-Codon principle, photochemical stages – primary and secondary processes. Jablonski diagram for photochemical process.	
2.0		**PHOTOCHEMICAL PROPERTIES OF TRANSITION METAL COMPLEXES:**	**20**
	2.1	Photophysical process.	
	2.2	Photochemical process: Photo substitution reactions, photo redox reactions, Photorearrangement reaction.	
	2.3	Prompt and Delayed Photochemical reactions.	
	2.4	Photolysis rules and ligand field theory.	
3.0		**PHOTOCHEMICAL REACTION OF COORDINATION COMPOUNDS:**	**15**
	3.1	Ligand field excited states i) Cr+++ ion complexes, Co+++ ion complexes, Rh+++ ion complexes and Ir+++ ion complexes.	
	3.2	Charge transfer excited states i) LMCT ii) MLCT iii) Charge transfer to solvent state.	
	3.3	Integrated excited state.	
4.0		**PHOTOREACTIONS:**	**10**
	4.1	In solar energy conversion.	
	4.2	Photographic systems.	
	4.3	Photosynthesis.	
		Total	**60**

Course outcomes:

1. Understand the mechanism of photochemical and photophysical processes.
2. Apply photophysical processes for versatile applications.

3. Analyze and interpret photoredox reactions.
4. Examine and classify photochemical reactions in coordination complexes.
5. Fabricate solar energy conversion devices.

Reference Books:

1. Progress in Inorganic Chemistry – Vol. 18 & 38 Edn J.J.Lipard Wiley
2. Supra molecular chemistry, J.M. Lehn, VCH
3. Concepts of Inorganic Photochemistry, A.W. Adamson, & T.D. Flkeischaue, Wiley
4. Elements of Inorganic photochemistry – G.J. Ferraudi

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M.Sc. Inorganic Chemistry, II Year (Semester - III)

Major Practical Course

Course Code – SCHECP1501

Title of the Course: Preparations and Characterisation (Conductance, Magnetic susceptibility, moisture)

[No. of Credits: 2 Credit] **[Total *60 Contact hrs*]**

Course objectives:

- To learn the multistage synthesis of Inorganic compounds and complexes.
- Become skilled for the synthesis of organometallics / complexes in the laboratory.
- Gain the practical knowledge of nano particle synthesis.
- To be trained in the characterization of the prepared inorganic molecules.

Curriculum Details: SCHECP1501: Inorganic Preparations and Characterization

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**30**
	1.1	Metal oxalate hydrate (Mg+2)	
	1.2	Sodium tetrationate Na2S4O6	
	1.3	Metal complexes of CuCl2.2DMSO	
	1.4	Ni (acac)2	
	1.5	Bromination of Ni(acac)3	
	1.6	Preparation of Ni(salicylaldoxime)2	
	1.7	Preparation of Co(α-nitroso-β-naphthol)3	
	1.8	Preparation of V(oxinate)3	
2.0			**30**
	2.1	Cis/trans [Co(en)2Cl2]+	
	2.2	[Co(phenanthroline)-5,6 quinone]	
	2.3	Ferrocene	
	2.4	Copper glycine complex (Cis/trans)	
	2.5	Hexa ammine Cobaltic complex	
	2.6	Hexaamine cobalt (III) chloride	
	2.7	Preparation of Trans-bis (glycinato)Cu(II)	
	2.8	Preparation of ZnO and Ag metal nanoparticles.	
		Total	**60**

Notes: i) Minimum 12 practicals should be completed.
ii) Any other related practicals can also be performed.

Course outcomes:

1. Learn basics practical knowledge of multistage synthesis of inorganic molecules.
2. Learn fundamentals of organometallics and its use.
3. Learn about nanoparticle synthesis by different techniques.
4. Learn about modern characterisation approaches of the synthesised compounds.

Reference Books:

1. A. L. Vogel, Quantitative Inorganic Analysis
2. G. Raj, Advanced Practical Inorganic Chemistry

3. P. C. Kamboj, University Practical Chemistry
4. Practical Inorganic Chemistry, G. Marr and B. W. Rocket, University Science Books, Ed. 1999.
5. Practical Inorganic Chemistry, G. Pass and H. Sutcliffe, Chapman and Hall, London, Ed. 1968.

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M.Sc. Inorganic Chemistry, II Year (Semester - III)

Practical Course

Course Code – SCHECP1502

Title of the Course: Inorganic Estimations

[No. of Credits: 2 Credit] **[Total *60 Contact hrs*]**

Course objectives:

- ❖ To learn the multistage estimations of Inorganic compounds and complexes.
- ❖ Become skilled for the analysis of organometallics / complexes in the laboratory.
- ❖ Gain the practical knowledge of material estimations.
- ❖ To be trained in the data expression of the estimated inorganic molecules.

Curriculum Details: SCHECP1502: Inorganic Estimations

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**A. Volumetric / Gravimetric**	**30**
	1.1	Estimation of Mg++ from metal oxalate hydrate complex by volumetric methods.	
	1.2	Estimation of Tin from Tin halide by Gravimetric methods.	
	1.3	Estimations of copper from copper DMSO complex by volumetric.	
	1.4	Estimation of Nickel from Ni(acac)2 by Gravimetric.	
	1.5	Estimation of chromium from cr(acac)3 by volumetric methods.	
	1.6	Estimation of cobalt from [Co(en)2Cl2]+.	
	1.7	Estimation of Iron from Fe(II) chloride by volumetric methods.	
2.0		**B. Ores / Materials**	**30**
	2.1	Estimation of metal ions in coins.	
	2.2	Estimation of metal ions in Bauxite ore.	
	2.3	Estimation of metal ions in Pyrolusite ore.	
	2.4	Estimation of Lead in red paints (Lead borate).	
	2.5	Estimation of calcium and magnesium in talcum powder.	
	2.6	Estimation of metal ions in fruits.	
	2.7	Estimation of metal ions in cement.	
	2.8	Estimation of Aluminum from its ore.	
	2.9	Estimation of calcium from drug sample.	
		Total	**60**

Notes: i) Minimum 12 practicals should be completed.
ii) Any other related practicals can also be performed.

Course outcomes:

1.Learn basics practical knowledge of multistage estimations of inorganic molecules.
2. Learn about various estimation techniques.
3. Learn about expression of the estimated compounds.

Reference Books:

1. A. L. Vogel, Quantitative Inorganic Analysis
2. G. Raj, Advanced Practical Inorganic Chemistry
3. P. C. Kamboj, University Practical Chemistry

4. Practical Inorganic Chemistry, G. Marr and B. W. Rocket, University Science Books, Ed. 1999.
5. Practical Inorganic Chemistry, G. Pass and H. Sutcliffe, Chapman and Hall, London, Ed. 1968.

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M.Sc. Chemistry, II Year (Semester - III)

Research Project Course

Course Code – SCHERP 1501

Title of the Course: Research Project

[No. of Credits: 4 Credit] **120 Periods**

Course objectives:

- ❖ To provide opportunity to involve in research related to Inorganic compounds, complexes, organometallics and nano materials.
- ❖ To gain the knowledge of referring research journals, writing research articles and submit the dissertation report.
- ❖ To inculcate research culture.
- ❖ To enhance the rational and innovative thinking capabilities.

Curriculum Details: SCHERP1501: Research Project

1. 0		**SYNTHESIS OF INORGANIC COMPLEXES / ORGANOMETALLICS / NANO MATERIALS**	
		Individual project can be taken up. Involve in literature survey in the chosen field. Use Scientific principles to solve identified issues. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective	
		Total	**120**

Note:

1. External and Internal Examiners will examine this project jointly at the time of Practical examination.
2. The students will have to give at least one seminar in each semester in their subject of specialization is compulsory.
3. Project work must be carried out only in specialized branch.
4. All synthesized compounds/complexes/materials should be submitted at the time of University Examination.
5. The project work carried out during the year should be presented in power point presentation in presence of University Examiners.

Course outcomes:

On completion of this course, the student should be able to:

1. Identify a research problem and carry out literature survey.
2. Analyse the research gap and formulate the problem.
3. Interpret the data and synthesize research findings.

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- Applying the knowledge of structure, bonding and reactivity of transition metals, rare metals, organometallics, bio-inorganic and inorganic Assemblies.
- To study the non-covalent forces and guest-host relationship.
- Analyzing real time problems and provide solutions.

Curriculum Details: SCHECT1551: Bioinorganic and Supramolecular Chemistry

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**BIOINORGANIC CHEMISTRY:**	**15**
	1.1	Introduction, Role of metals and non-metals in biological systems. **Metal storage and transport:** Alkali and Alkaline Earth metals: Na/K pump, Ca pump, transport of Ca++ in microbes. Supply and storage of iron: Ferittin, transferittin and Sidprophores. Storage and transport of copper and zinc. Transport and storage of other metals. **Transport and storage proteins: Oxygen transport and storage:** Oxygen carrier myoglobin and haemoglobin, Hemerythrin and Hemocyanin.	
	1.2	Importance of order of events in organic synthesis, one and two group C-X disconnections, selective organic transformations,	
	1.3	Chemoselectivity, regioselectivity, stereoselectivity, enentioselectivity, Reversal of polarity, cyclization reactions, amine synthesis.	
	1.4	Protecting Groups: Protection and deprotection of hydroxyl, carbonyls in aldehydes and ketones, amines, carboxylic acids, alkenes and alkynes.	
2.0		**METALS IN MEDICINES:**	**15**
	2.1	**Metals and its complexes as a therapeutic agent**: Chelation Therapy: BAL, Pencillamine, Polyaminopolycarboxylic acids, Aurine Tricarboxylic acid, Desferrioxamine and Crptates.	
	2.2	Gold Compounds and Rheumatoid Arthritis.	
	2.3	Anticancer Drugs: Platinum, Gold, Metallocenes and other complexes	
	2.4	Metal deficiency: Iron, Copper, Zinc, Cobalt, and other metal toxicity. Chemistry of Vitamin B12.	
3.0		**SUPRAMOLECULAR CHEMISTRY:**	**15**
	3.1	**Concept and language:** Molecular recognition: Molecular receptors for different types of molecules including cationic, anionic substrates, design and synthesis of coreceptor molecules and multiple recognition.	
	3.2	**Supra molecular reactivity and catalysis:** Anion receptor molecules, metallo receptor molecules and co-catalysis.	
4.0		**SUPRAMOLECULAR ASSEMBLIES:**	

Course outcomes:

1) Recollect the principles of electronic structure, bonding, and reactivity of coordination complexes
2) Understand the concept of Metallobiomolecules, their role and functions in biological systems.
3) Apply the principles of transition metal coordination complexes in understanding functions of biological systems
4) Learning guest-host analogy and applying in the huge molecular assemblies.
5) Develop the possible catalytic pathways leading to tailored molecules.

References

1. Principles of bioinorganic chemistry, S. J. Lipard and J. M. Berg University science book
2. Bioinorganic Chemistry, I. Bertine, H.B. Grey, S.J. Lipard, University Science book
3. Progress in Inorganic Chemistry – Vol. 18 & 38 Edn J.J. Lipard Wiley
4. Supra molecular chemistry, J.M. Lehn, VCH
5. Bioionorganic and supramolecular chemistry, Ajay Kumar Bhagi and G.R. Chatwal, Himalaya Publication.
6. Bioinorganic Chemistry, K. Hussain Reddy, New Age International.
7. An Introduction to Supramolecular Chemistry, A. K. Das, M. Das, CBS Publishers.

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M.Sc. Inorganic Chemistry, II Year (Semester - IV)

Major Core Theory Course

Course Code – SCHECT1552

Title of the Course: Instrumental Methods in Inorganic Chemistry

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- To learn to probe interaction of inorganic matter with heat.
- To know the investigative principle of voltammetry and amperometry.
- Understand and characterize surfaces using spectroscopy and microscopy

Curriculum Details: SCHECT1552: Instrumental Methods in Inorganic Chemistry

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		THERMAL TECHNIQUES:	

Course outcomes:

1) Apply the knowledge about thermal methods for the characterization of the inorganic compounds.
2) Understand the instrumentation and working of voltammetry and potentiometry and their techniques
3) Able to elucidate and characterize surfaces on probing with spectroscopy and microscopy.

References books

1. Analytical Chemistry – G. D. Christian, J. Wiley
2. Fundamentals of analytical Chemistry – Skoog, West and F. J. Holler, W. B. Saunders
3. Analytical Chemistry, principles, J. H. Kenedy, W. B, Saunders
4. Principles of Instrumental Analysis, D. A. Skoog, W. B. Saunders
5. Basic concepts of analytical. Chemistry – S. M. Khoppkar, wiley Eastern
6. Quantitative analysis – R. A. Day, Jr and A. L. Underwood, Prentice Hall

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M.Sc. Inorganic Chemistry, II Year (Semester - IV)

Major Elective Theory Course

Course Code – SCHECE1551

Title of the Course: Selected Applications of Inorganic Chemistry

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- Understanding structure, bonding and reactivity involved in inorganic metal complexes
- Applying practical aspects of inorganic chemistry in research and development
- Applying practical aspects of quantum chemistry, spectroscopy, symmetry and group theory in different research problems.
- Understanding the theories behind the interpretation of rotational, vibrational and Raman spectra of inorganic molecules.

Curriculum Details: SCHECE1551: Selected Applications of Inorganic Chemistry

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**SCHIFFS BASE LIGANDS AND THEIR COMPLEXES**:	**15**
	1.1	i. Introduction ii. Classification of ligands iii. Synthesis and purification iv. Spectroscopic properties v. Structural properties vi. Bonding to metal vii. Ligand properties and conformational aspects, applications	
	1.2	Stability Constants: Methods for Determining Stability Constants of Coordination Compounds such as Potentiometry, Spectroscopic methods viz., Job's method, mole-ratio and slope-ratio methods for determination of stepwise formation constants of metal complexes. Conductometry Polarography (Numerical).	
	1.3	Stability Constants of Mixed Ligand Complexes.	
2.0		**APPLICATION OF GROUP THEORY-SPECTRAL PROPERTIES:**	**15**
	2.1	Recapitulation of Point groups, Classes, Representations and Character Table.	
	2.2	Reduction of Reducible Representations into corresponding Irreducible components. (Numerical)	
	2.3	Molecular Vibrations: The Symmetry of Normal Vibrations; Determining the Symmetry Types of the Normal Modes; Selection Rules for Fundamental Vibrational Transitions (IR and Raman) and Interpretation of IR and Raman Spectra e.g. H2O, NH3, CO2, HF, H2; comparison of IR and Raman selection rules.	
3.0		**ESR SPECTROSCOPY OF INORGANIC COMPOUNDS**:	
	3.1	Theory of EPR spectroscopy - Spin densities and McConnell relationship – Factors affecting the magnitude of g and A tensors in metal species,	
		Calculation of g-values with examples. Intensities of g∥ and g⊥ peaks	

Course outcomes:

1. Examine and apply the structural arrangement in inorganic complexes
2. Apply ESR and Mössbauer technique for complex analysis.
3. Evaluate and interpret structure property relationship of metal complexes.
4. Explore the applications of group theory in molecular spectroscopy.
5. Apply the quantum chemistry, group theory and molecular spectroscopy to solve real world problems

References books:

1. James Huheey, F. A. Keiter and R. I. Keiter, Inorganic Chemistry – Principles of Structure and Reactivity, 4th Edition, Harper Collins, 1993
2. Gary Miessler and Donald Tarr, Inorganic Chemistry, 3rd Ed. Pearson Education, 2004.
3. Puri, Sharma and Kalia, Principles of Inorganic Chemistry – 31st Edition, Milestone Publishers, 2010.
4. D. Banerjea, Coordination Chemistry, Tata McGraw Hill, New Delhi, 1993.
2. Gopalan and Ramalingam, Concise coordination chemistry 2012.
3. K.Veera Reddy, Symmetry and Spectroscopy of molecules, 2nd ed, New Age International Publishers.
4. U.C. Agarwala, H/L/Nigam, S Agarwal, S. S. Kalra, Molecular symmetry in Chemistry via group theory, 2013, Ane Books Pvt.ltd.
5. H. N. Dass, symmetry and group theory for chemists, 2004 Asian Books Pvt. Ltd.
6. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarisi, A simple approach to Group theory in chemistry, 2008, Universities Press (India) Pvt. Ltd.
7. Fmiza Hammer, Inorganic spectroscopy and related topics, Sarup & Sons (2008)
8. R. S. Drago, Physical methods in Inorganic chemistry, Affiliated East-West Press Pvt. Ltd; New Delhi
9. R. V. Parish, NMR, NQR, EPR and Mossbauer spectroscopy in Inorganic Chemistry, Ellis Horwood. (1990)
10. D. N. Sathyanarayana, Introduction to magnetic resonance spectroscopy ESR, NMR, NQR, I. K. Intenational publishing house pvt. Ltd. (2009).
11. Ebsworth, E. A. V., Structural Methods in Inorganic Chemistry, 3rd edition, ELBS, Great Britain, 1987.
12. Solomon, E. I., Lever, A. B. P., Inorganic Electronic Structure and Spectroscopy, Vol., 2, Applications and Case Studies, Wiley-Interscience, 2006.
13. Gerson, F., and Huber, W., Electron Spin Resonance Spectroscopy for Organic Radicals, Wiley-VCH, 1st edition, 2001
14. Syamal and Dutta, Elements of magnetochemistry

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M.Sc. Inorganic Chemistry, II Year (Semester - IV)

Major Elective Theory Course

Course Code – SCHECE1551

Title of the Course: Nuclear and Radiochemistry

[No. of Credits: 4 Credit] **[Total 60 Lectures]**

Course objectives:

- To study the radioactivity and decay process.
- To learn various nuclear reactions and models.
- Know about nuclear reactors and its working.
- Understand current nuclear scenario of India.

Curriculum Details: SCHECE1551: Nuclear and Radiochemistry

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**RADIOACTIVITY:**	**15**
	1.1	Radioactive elements, Characteristics of Radioactive decay. Systematic alpha, Beta, Gamma decays Alpha decays, energy curves, Alfa particle energy spectrum, GN law, Theory of alpha decay.	
	1.2	Types of Beta decays, Electron capture reaction, Range of energy relationship of beta particle, beta positive decays, Dirac's theory of positron.	
	1.3	Gamma emission, gamma decays constant, internal conversions, Auger effect.	

Course outcomes:

1. Able to acknowledge various decay process.
2. To understand the working of reactors and operate.
3. Apply nuclear technology for common use.

References books

1. Essentials of Nuclear Chemistry by H.J. Arnikar, Wiley Eastern Pvt. Ltd, News Delhi (1990)
2. Source of Book of Atomic Energy, by S. Glasstone, Affiliated East We3st Press ltd., New Delhi (1967)
3. Nuclear chemistry by U.N. Dash, Sultan Chand and sons, New Delhi (1991)
4. Introduction to Radiation chemistry, by J.W.t. Spinks, and R.j. Woods, John-Wiley and Sons, New York (1964)
5. Nuclear and radiation Chemistry by B.K. Sharma. Goel Publishing House, Meerut (1997)

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M.Sc. Inorganic Chemistry, II Year (Semester - IV)

Practical Course

Course Code – SCHECP1551

Title of the Course: Instrumental / Chromatographic Analysis

[No. of Credits: 2 Credit] **[Total *60 Contact hrs*]**

Course objectives:

- To train various instrumental methods of analysis.

- ❖ Become skilled with the handling of inorganic samples and instruments.
- ❖ Gain the practical knowledge of principle and working of instruments.
- ❖ To explore various techniques of electroanalytical, spectrophotometric and chromatographic methods.

Curriculum Details: SCHECP1551: Instrumental / Chromatographic Analysis

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**SPECTROPHOTOMETRY:**	
	1.1	Simultaneous determination: in steel i] Manganese / Chromium ii] Vanadium and titanium iii] Chromium and cobalt	
	1.2	Determination of Nickel by spectrophotometric methods	
	1.3	Determination of Tungsten by Spectrophotometric method	
	1.4	Determination of Fluoride by Spectrophotometer.	
	1.5	Job-method Zirconium Alizarin red – 5-complex (mole-ratio method)	
	1.6	Stoichiometry and stability of Fe^{+3} salicylate complex by jobs and mode ratio method	
	1.7	Stoichiometry and stability of Fe^{+3} thiocynate complex by jobs and mode ratio method	
2.0		**FLAME PHOTOMETRY:**	
	2.1	Estimation of sodium in Electral powder / given sample.	
	2.2	Estimation of potassium in Fertilizer / given sample.	
	2.3	Estimation of calcium	
	2.4	Estimation of Lithium	
	2.5	Estimation of Cd++ and Mg++ in tap water	
3.0		**CHROMATOGRAPHY:**	
	3.1	Separation of Cd++ and Zn++ by paper chromatography. Determine its RF value	
	3.2	Separation of Ni++ and, Co by paper chromatography. Determine their Rf value	
	3.3	Separation of Cd++ and Zn++ by TLC. Determine their Rf value	
4.0		**POTENTIOMETRY/CONDUCTOMETRY/ PH METRY:**	
	4.1	Determine the redox potential of Fe (II)/Fe (III) system and hence determine the number of electrons involved in the system using K2Cr2O7 by potentiometric method.	
	4.2	Determine the amount of chloride, bromide and iodide in the given sample by potentiometric method.	
	4.3	Analyze the acid mixture of hydrochloric acid and acetic acid by conductometric method.	
	4.4	Analyze the mixture of copper sulphate, hydrochloric acid and acetic acid by conductometric method.	
	4.5	Determine the pK value of Glycine by using Irrivaing Rastogi method by pH metry.	
		Determine the metal ligand stability constant of copper benzoate complex by pH metric method.	
		Total	**60**

Note: i) Minimum 12 practicals should be completed.
ii) Any other related practicals can also be performed.

Course outcomes:

1. Learn basics practical knowledge of instrumental analysis.
2. Learn the use of various techniques of classified analysis for the given sample.
3. Learn about modern methods of electroanalytical, spectrophotometric and chromatographic techniques.

Reference Books:

1. A. L. Vogel, Quantitative Inorganic Analysis
2. G. Raj, Advanced Practical Inorganic Chemistry
3. P. C. Kamboj, University Practical Chemistry
4. Practical Inorganic Chemistry, G. Marr and B. W. Rocket, University Science Books, Ed. 1999.
5. Practical Inorganic Chemistry, G. Pass and H. Sutcliffe, Chapman and Hall, London, Ed. 1968.

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M.Sc. Chemistry, II Year (Semester - IV)

Research Project Course

Course Code – SCHERP 1502

Title of the Course: Research Project

[No. of Credits: 6 Credit] **180 Periods**

Course objectives:

- To provide opportunity to involve in research related to Inorganic compounds, complexes, organometallics and nano materials.
- To gain the knowledge of referring research journals, writing research articles and submit the dissertation report.
- To inculcate research culture.

- ❖ To enhance the rational and innovative thinking capabilities.

Curriculum Details: SCHERP1502: Research Project

1. 0		**SYNTHESIS OF INORGANIC COMPLEXES / ORGANOMETALLICS / NANO MATERIALS**	
		Individual project can be taken up. Involve in literature survey in the chosen field. Use Scientific principles to solve identified issues. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective	
		Total	**180**

Note:

1. External and Internal Examiners will examine this project jointly at the time of Practical examination.
2. The students will have to give at least one seminar in each semester in their subject of specialization is compulsory.
3. Project work must be carried out only in specialized branch.
4. All synthesized compounds/complexes/materials should be submitted at the time of University Examination.
5. The project work carried out during the year should be presented in power point presentation in presence of University Examiners.

Course outcomes:

On completion of this course, the student should be able to:

1. Identify a research problem and carry out literature survey.
2. Analyse the research gap and formulate the problem.
3. Interpret the data and synthesize research findings.