

**SARDAR PATEL UNIVERSITY  
VALLABH VIDYANAGAR**



**SYLLABUS EFFECTIVE FROM: 2018-19  
M.Sc. CHEMISTRY  
SEMESTER III**

**INORGANIC CHEMISTRY  
(Total 650 marks)**

Course Code	Course Title	Hours per week	Internal Marks	External Marks	Total Marks
PS03CINC21	Spectroscopy - I	4 hrs	30	70	100
PS03CINC22	Nuclear Chemistry and Reaction Mechanism	4 hrs	30	70	100
PS03CINC23	Organometallic Compounds	4 hrs	30	70	100
PS03EINC21-22	Any One	4 hrs	30	70	100
PS03CINC24	Practicals OR	8 hrs	30	70	100
PS03CINC25	Project Work	8 hrs	30	70	100
PS03CINC26	Practicals OR	8 hrs	30	70	100
PS03CINC27	Project Work	8 hrs	30	70	100
PS03CINC28	Comprehensive Viva	1 hrs	-	50	50
Total Marks					650

\* **Project work** (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

**PS03CINC21: Spectroscopy-I**

<b>Unit-1</b>	<p><b>Infrared Spectroscopy</b> Theory of Infrared (IR) Spectroscopy, Molecular vibrations, Characteristic group absorption frequencies, Interpretation of spectra.</p> <p><b>Ultraviolet Spectroscopy</b> Theory of electronic transition and Ultraviolet (UV) absorptions, chromophores and auxochromes, Woodward-Fieser rules, Characteristic absorptions in various compounds</p>	<b>25%</b>
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<b>Unit-2</b>	<b>Nuclear Magnetic Resonance Spectroscopy</b> <sup>1</sup> H Nuclear Magnetic Resonance ( <sup>1</sup> H NMR) spectroscopy, Chemical shifts and factors affecting chemical shifts, Splitting of the signals – spin couplings and coupling constants, Chemical shift equivalence and magnetic equivalence, <sup>13</sup> C-NMR spectroscopy, Proton coupled and decoupled <sup>13</sup> C NMR spectra, Chemical shifts in <sup>13</sup> C NMR spectra and their calculation, <sup>13</sup> C- <sup>1</sup> H coupling constants, <sup>13</sup> C - DEPT spectra, Nuclear Overhauser Effect, NMR Spectroscopy of other important spin ½ nuclei, Interpretation of NMR spectra	<b>25%</b>
<b>Unit-3</b>	<b>Electron Spin Resonance Spectroscopy</b> Theory of Electron Spin Resonance (ESR) Spectroscopy, Instrumentation, Factors affecting the g-values, Differences between NMR and ESR, Hyperfine interactions, Interpretation of ESR spectra, Applications of ESR	<b>25%</b>
<b>Unit-4</b>	<b>Mass Spectroscopy</b> Theory of Mass Spectroscopy, Instrumentation, Ionization techniques, Mass analyzers, Fragmentations and rearrangements, Interpretation of mass spectra, Determination of molecular formula, Mass spectra of some chemical classes	<b>25%</b>

#### Reference Books

1. Spectroscopic Identification of Organic Compounds by R. M. Silverstein and F. X. Webster, 6<sup>th</sup> edition, John Wiley & Sons.
2. Introduction to Spectroscopy by D. L. Pavia, G. M. Lampman and G. S. Kriz, 3<sup>rd</sup> edition, Thomson Brooks/Cole.
3. Spectroscopic Methods in Organic Chemistry by D. H. Williams and I. Fleming, 4<sup>th</sup> edition, Mcgraw–Hill Book Company.
4. Organic Spectroscopy by William Kemp, 3<sup>rd</sup> edition, Palgrave.
5. Organic Spectroscopy–Principles and Applications by Jag Mohan, 2<sup>nd</sup> edition, Narosa Publishing House.
6. Spectroscopy of Organic Compounds by P. S. Kalsi, 5<sup>th</sup> edition, New Age International Publishers.

## PS03CINC22: Nuclear Chemistry and Reaction Mechanism

<b>Unit-1</b>	<b>Nuclear Chemistry-I</b> Introduction, Nuclear binding energy, Radioactivity and nuclear reactions, Nuclear fission and nuclear fusion, Spectroscopic techniques based on nuclear properties, <i>Ortho</i> - and <i>para</i> - hydrogen, The separation of stable isotopes, The separation of unstable isotopes	<b>25%</b>
<b>Unit-2</b>	<b>Nuclear Chemistry-II</b> Electrochemical applications, Applications of radioactivity in analytical chemistry, The biochemical, physiological and medicinal application of isotopic tracers, Technological and industrial applications	<b>25%</b>
<b>Unit-3</b>	<b>Reaction Mechanism-I</b> The nature of substitution reaction, Theoretical approach to substitution mechanism, Nucleophilic reactivity, Nature of central atom, Kinetic application of crystal field theory, Replacement of coordinated metal, Acid analysis, Molecular rearrangement complexes, Reactions of geometrical and optical isomers	<b>25%</b>
<b>Unit-4</b>	<b>Reaction Mechanism-II</b> Isomerisation and racemization of octahedral complexes, Ligand stereospecificity, Outersphere electron transfer reactions, Innersphere electron transfer reactions, The nature of the bridge ligand, Two electron transfer, Noncomplementary reactions, Synthesis of coordination compounds using electron transfer reactions	<b>25%</b>

### Reference Books

1. Inorganic Chemistry by Alan G. Sharpe, Pearson Pub.
2. Nuclear Chemistry and its applications by M. Haissinky, Addison-Wesley Pub.
3. Mechanism of Inorganic Reactions by F. Basolo and R. G. Persons, Wiley Pub.
4. Reaction Mechanism of Coordination Compounds by C. H. Langford and H. B. Gray.
5. Inorganic Reaction Mechanisms by M. L. Tobe, Nelson Pub.
6. Inorganic Chemistry by K.F. Purcell and J. C. Kotz.
7. Fundamental Principles of Inorganic Chemistry by D. Banerjea
8. Inorganic Chemistry by Shriver and Atkins
9. Inorganic Chemistry by James E. huheey, Ellen A. Keiter and Richard L. Keiter
10. Essentials of Nuclear Chemistry by H. J. Arnika, Wiley Eastern Limited, New Delhi
11. Elements of Nuclear Chemistry by R. Gopalan, Vikas Publishing House Pvt.Ltd.
12. Nuclear Chemistry, Bernard G. Harvey by Prentice - Hall, Inc., Englewood Cliffs, N.J.

### PS03CINC23: Organometallic Compounds

<b>Unit-1</b>	<b>Introduction to organometallic compounds</b> Introduction, classifications and general characteristics of organometallic compounds, Organometallic compounds of main group elements– characteristics, stability, preparative methods, group trends and some typical chemical reactions Organometallic compounds of transition metals– $\pi$ -bonded and $\sigma$ -bonded organometallics, synthesis, properties and typical reactions	<b>25%</b>
<b>Unit-2</b>	<b>Synthetic and catalytic aspects of main group organometallic compounds</b> Synthetic applications of main group organometallic compounds as stoichiometric reagents–organolithium, organosodium, organopotassium, organomagnesium, organozinc, organocadmium, organomercury, organoboranes, organoaluminium, organothalium, organosilicon and organotin, Catalytic applications of main group organometallic compounds	<b>25%</b>
<b>Unit-3</b>	<b>Transition metal organometallic compounds as catalysts and synthetic reagents</b> Catalytic processes involving transition metal organometallic compounds as homogeneous catalysts – hydrogenation, hydroformylation, oxidation, isomerization, dimerization and polymerization of alkenes and alkenes metathesis, Catalytic processes based on carbon monoxide and transition metal organometallic compounds as catalysts, Mechanism of reactions catalyzed by transition metal organometallics, Applications of transition metal organometallic compounds as synthetic reagents	<b>25%</b>
<b>Unit-4</b>	<b>Biological application and environmental aspects of organometallic compounds</b> Introduction, Organometallics in medicine, Organometallics in agriculture and horticulture, Organometallics in industry, environmental aspects of organometallic compounds.	<b>25%</b>

#### Reference Books

1. Organometallic Compounds, Vol.1 & 2 by G.E. Coates, M.L.H. Green and K. Wade, Methuen & Co. Ltd. London EC4.
2. Organometallic Compounds by G.E. Coates, John Wiley & Sons, Inc., New York.
3. Organometallic Chemistry by H. Zeiss, Reinhold Publishing Corporation, New York.
4. Organometallic Chemistry by R.C. Mehrotra & Anirudh Singh, New Age International (P) Limited, Publishers, New Delhi.
5. Progress in Inorganic Chemistry, Vol. 1 by F.A. Cotton, Interscience, Pub.Inc., New York.
6. Organotransition Metal Chemistry by John F. Hartwing, University Science Books, Sausalito, California.

**PS03EINC21: Applications of Inorganic Chemistry in Industry**

<b>Unit-1</b>	<b>Pigments</b> Introduction; Pigments in foods–naturally occurring plant- and animal- pigments; Synthetic food pigments such as Sunset yellow, Allura red, etc.; pigments in plants – raw materials for paints; Physical properties of the pigments in paints; Brief descriptions of the manufacturing process and use of commonly used pigments such as White lead, Zinc oxide, Titanium dioxide, etc.	<b>25 %</b>
<b>Unit-2</b>	<b>Electrochemical Applications</b> Introduction; brief discussion on classical electrodeposition of metals; Advancement in the electrochemical industry–modification of electrode surface, brief discussion with respect to preparations and properties of surface modified electrodes such as nafion modified electrodes, pvp modified electrodes, etc.; Applications of surface modified electrodes such as Electrocatalysis, ion selective electrodes, etc.	<b>25 %</b>
<b>Unit-3</b>	<b>Corrosion Inhibitors</b> Introduction, Types of corrosion Principles of corrosion inhibitors, corrosion as an electrochemical process, Practical aspects of corrosion inhibition, Anion inhibitor properties in neutral electrolytes, some application of corrosion inhibitors (cooling water circulation-once through and open systems, engine radiation & cooling systems, central heating system, refrigeration plants and high chloride systems, water for steam raising, corrosion inhibitors for paint coating)	<b>25 %</b>
<b>Unit-4</b>	<b>Waste and Waste Water Technology</b> Water processing, Operation of waterworks, Wastewater flows and characteristics, Wastewater collection systems, Wastewater processing, Operation of wastewater systems, Advanced wastewater treatment, Water reuse	<b>25 %</b>

**Reference Books**

1. Handbook of Industrial Chemistry, Vol.1 by K.H.Davis, F.S.Berner, CBS Publishers, Bangalore.
2. Comprehensive Coordination Chemistry, Chapter 57, 58.
3. Insight into Speciality Inorganic Chemicals, Chapter 15, by David Thompson, The Royal Society of Chemistry, 1995.
4. New Trends in Green Chemistry, 2<sup>nd</sup> Edition by V.K.Ahluwalia and M.Kidwai, Anamaya Publishers, 2007.
5. Water and Wastewater Technology, 4<sup>th</sup> edition by Mark J. Hammer and Mark J. Hammer Jr., Eastern Economy Edition.
6. Wastewater engineering by Calf and Eddy.
7. Wastewater treatment for pollution control by Arceivala.
8. Manual on sewage & sewage treatment, Ministry of Works, Delhi.
9. Principles of water quality control by T.H.Y. Tebbut.

## PS03EINC22: Selected Topics in Advanced Inorganic Chemistry-I

<b>Unit-1</b>	<b>Heterogeneous Catalysis: Fundamentals and Applications</b> Introduction, Definition of catalysis, Types of catalysis, Basics of heterogeneous catalysis, advantages of heterogeneous catalysis, supports for heterogeneous catalysis, Catalytic process, Aspects of heterogeneous catalysis in green chemistry, Applications of heterogeneous catalysis	<b>25%</b>
<b>Unit-2</b>	<b>Metal Organic Frameworks</b> Introduction to MOFs, Synthesis of MOFs, Post-synthetic modification of MOFs, Characterization of MOFs, Application of MOFs as catalysts, nanoreactors, gas storage devices, etc.	<b>25%</b>
<b>Unit-3</b>	<b>Polyoxometalate Chemistry From Topology via Self-Assembly to Applications</b> Introduction to Polyoxometalate Chemistry, Synthetic Methodologies, POM-Based Supramolecular Structures, Applications of POM in Catalysis, Biological systems and environmental studies	<b>25%</b>
<b>Unit-4</b>	<b>Advances in Nanomaterials</b> Types of nanomaterials, e.g. nanotubes, nanorods, solid spheres, core-shell nanoparticles, Mesoporous materials; General preparative methods for various nanomaterials, Some important properties of nanomaterials: optical properties of metal and semiconductor nanoparticles, magnetic properties, Some special nanomaterials: Carbon nanotubes: Types, synthesis using various methods, growth mechanism, electronic structure; Porous silicon: Preparation and mechanism of porous silicon formation, Factors affecting porous structure, properties of porous silicon; Aerogels: Types of aerogels, Properties and applications of aerogels, Applications of nanomaterials in electronics, energy, automobiles, sports and toys, textile, cosmetics, medicine, space and defense. Environmental effects of nanotechnology	<b>25%</b>

### Reference Books

1. Sulabha K. Kulkarni, Nanotechnology-Principles and Practices, Capital Publishing Co., 2007.
2. Polyoxometalate Chemistry From Topology via Self-Assembly to Applications by Michael T. Pope and Achim Müller, Kluwer Academic Publishers, New York.
3. Advances in Inorganic Chemistry by Rudi van Eldik, Lee Cronin-Polyoxometalate Chemistry, 2017, Zoe Kruze.
4. Modern Heterogeneous Catalysis by Rutger A. van Santen, Wiley-VCH.
5. Heterogeneous Catalysis: Fundamentals and Applications by Julian R.H. Ross, Elsevier.
6. Handbook of Green Chemistry, Green Catalysis, Vol. 2 by Paul T. Anastas, Wiley-VCH.
7. Polyoxometalate Molecular Science, NATO Science Series, Vol. 98.

8. Nanoparticle Technology for Drug Delivery, Ram B. Gupta and Uday B. Kompella, Taylor & Francis.
9. Introduction to heterogeneous catalysis by Per Stoltze.
10. Metal-Organic Frameworks: Applications from Catalysis to Gas Storage edited by Dr. David Farrusseng, Wiley-VCH.
11. Metal Organic Frameworks as Heterogeneous Catalysts, RSC Catalysis Series, edited by James J Spivey, RSC, 2013.
12. Nanotechnology by S. Shanmugam, MJP Publisher.
13. Porous materials by Duncan W. Bruce, Dermot O'Hare, Richard I. Walton, Wiley-VCH.

## **PRACTICALS: PS03CINC24**

### **Synthesis and structural characterization of following coordination compounds (8 hrs)**

1. Synthesis of bis(salicylidene)ethylenediamine Co(II) complex.
2. Synthesis of bis(8-quinolinol)bis(benzylidene)ethane-1,2-diamine Ni(II) complex.
3. Synthesis of bis(8-quinolinol)bis(4-methoxybenzylidene)ethane-1,2-diamine Co(II) complex.
4. Synthesis of bis(8-quinolinol)bis(benzalidene)ethylenediamine Cu(II) complex.
5. Synthesis of bis(salicylidene) thiosemicarbazide Ni (II) (TSC) complex.
6. Synthesis of bis(salicyldehydato)diaquacobalt(II) chelate
7. Synthesis of bis(salicylidene)bis(4-chlorobenzylidene)ethane-1,2-diamine Cu(II) complex.
8. Synthesis of tris (acetylacetonato) Mn(III) chelate
9. Synthesis of bis(8-quinolinol)bis(4-hydroxy benzylidene)ethane-1,2-diamine Cu(II) complex.
10. Synthesis of bis(8-hydroxy quinoline)bis(4-chloro benzylidene)*o*-phenylenediamine with Cu(II) complex.
11. Synthesis of mercury tetrathiocyanate cobalt(II)
12. Miscellaneous

### **Reference books:**

1. Qualitative Chemical semimicroanalysis by V. N. Alexeyev, Mir Publishers Moscow.
2. Vogel's Qualitative Inorganic Analysis by G. Svehla, Orent Longman, New Delhi.
3. Vogel's Textbook of Quantitative Chemical Analysis, 5<sup>th</sup> edition by G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, ELBS Publication, 1996, Chapter 2, 3, 11.



## **PRACTICALS: PS03CINC26**

### **Spectrophotometric techniques (8 hrs)**

1. Determine the composition of the complexes formed in the system Fe(III) salisaldehyde in acidic medium pH-2 by mole ratio method.
2. Determine the nature of the complexes formed in the system Cu(II) ethylene diamine in water.
3. Determine the nature of the complexes formed in the system Ni(II) ethylene diamine in water.
4. Determine the nature of the complexes formed in the system Fe(III) salisaldehyde/5-suphosalisylic acid in acidic medium (0.01M W.R.T HNO<sub>3</sub>) using spectrophotometric method.
5. Determine the composition of the complexes formed in the system Cu(II) ethylene diamine in acidic medium pH-2 by slope ratio method.
6. Determine the composition of the complexes formed in the system Ni(II) ethylene diamine in acidic medium pH-2 by slope ratio method.
7. Determine the composition of the complexes formed in the system Fe(III) ethylene diamine in acidic medium pH-2 by slope ratio method.
8. Determine the composition of the complexes formed in the system Cu(II) ethylene diamine in acidic medium pH-2 by mole ratio method.
9. Determine the composition of the complexes formed in the system Ni(II) ethylene diamine in acidic medium pH-2 by mole ratio method.
10. Determine the stability constant of the complexes formed in the system Cu(II) ethylene diamine by Job's method of continuation variation
11. Determine the stability constant of the complexes formed in the system Ni(II) ethylene diamine by Job's method of continuation variation
12. Determine the stability constant of the complexes formed in the system Fe(III) salisaldehyde/5-suphosalisylic acid in acidic medium(pH-2) by Job's method of continuation variation.
13. Determine spectrophotometrically the pK value of an indicator (the acid dissociation constant of methyl red).
14. Determination of concentration of cobalt and chromium in a given mixture of the sample.
15. Miscellaneous

### **Reference book:**

1. Modern Analytical Chemistry, 1<sup>st</sup> Edition by D. Harvey, The McGraw-Hill Pub, 2000.
2. Instrumental Methods of Analysis, 4<sup>th</sup> edition by G.W. Ewing, McFraw Hill Ltd., 1970.
3. Physical Methods in Inorganic Chemistry by R. S. Drago, John-Wiley Pub., 1975.

**OR**

**PS03CINC25 and PS03CINC27:**

\* **Project work** (as optional) in place of practicals; to be offered to some of the students, based on their merit, interest and placement with the teachers (Marks : 200). The project shall have to be carried out under the allotted teacher(s) and a dissertation shall be submitted and will be assessed for internal (60 marks) and external (140 marks), in the usual manner.

<b>Paper Code:</b> PS03CINC28	<b>Total Credit: 1</b>
<b>Title of Paper:</b> Comprehensive Viva	

<b>Description in detail</b>	<b>Weightage (%)</b>
Viva Voce From the Subjects Studied in Semester - III	100%