Shri Vile Parle Kelavani Mandal's

MITHIBAI COLLEGE OF ARTS, CHAUHAN INSTITUTE OF SCIENCE & AMRUTBEN JIVANLAL COLLEGE OF COMMERCE AND ECONOMICS (AUTONOMOUS)

NAAC Reaccredited 'A' grade, CGPA: 3.57 (February 2016),

Granted under RUSA, FIST-DST & -Star College Scheme of DBT, Government of India

Best College (2016-17), University of Mumbai

Affiliated to the

UNIVERSITY OF MUMBAI

Program: M. Sc. (Inorganic Chemistry)

Semester III

Credit Based Choice System (CBCS) with effect from the Academic year 2020-21

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the M.Sc. Inorganic Chemistry, the learners should be enriched with knowledge and be able to-

PSO1: Qualify the national and state level entrance exams such as CSIR-NET, SET, GATE for pursuing Ph.D.

PSO2: Apply advanced concepts in inorganic chemistry to solve complex chemical problems.

PSO3: Design experiments, analyse, synthesize and interpret data to provide solutions to different industrial problems by working in the pure, inter and multi-disciplinary areas of chemical sciences.

PSO4: Independently carry out research in the areas related to materials, coordination compounds, catalysis and nanotechnology

Preamble

The purpose of post-graduate education in Science is to create highly skilled manpower in specific areas, which will lead to generation of new knowledge and creation of wealth for the country. Chemistry is a fundamental science and has contributed immensely to the improvement of the life of human beings by providing many of human requirements and essentialities. The credit system has been adopted for all these courses, which would allow students to develop a strong foundation in the fundamentals and specialize in the disciplines of his/her liking and abilities. The courses are designed so that the students pursuing these courses will obtain fundamental knowledge about the subject in the respective specialization. The students are also expected to get corresponding experimental training during the practical courses.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Evaluation Pattern

The performance of the learner will be evaluated in two components. The first component will be a Continuous Assessment with a weightage of 25% of total marks per course. The second component will be a Semester end Examination with a weightage of 75% of the total marks per course. The allocation of marks for the Continuous Assessment and Semester end Examinations is as shown below:

a) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Test	15 marks
Component 2 (CA-2)	Assignment	10 marks

b) Details of Semester End Examination

75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
Q.1	Answer any four out of five	05	20
Q.2	Answer any four out of five	05	20
Q.3	Answer any four out of five	05	20
Q.4	Answer any four out of five	05	20
Q.5	Answer any three out of four	05	15
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Inorganic Chemistry)				**Semester : III**	
Course : Chemistry of Inorganic Solids				**Course Code: PSMACHI301**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Learning Objectives:

Aim of the course is to provide a sound fundamental theoretical understanding of different structural forms of inorganic solids, their methods of preparation and behavior. It also elaborates the types of imperfections involved in crystals.

Course Outcomes:

After completion of the course, students would be able to :

CO1: Understand the different structural forms of crystals with adequate examples.
CO2: Explain the linked polyhedral and types of sharing involved.
CO3: Describe the point defects in stoichiometric and non-stoichiometric compounds.
CO4: Find defect concentration by using mathematical derivations.
CO5: Synthesize inorganic solids using single crystal growth methods.
CO6: Classify liquid crystals and also understand their properties and applications.

Outline of Syllabus: (per session plan)

Module	Description	No of Hours
1	**1.1 Descriptive Crystal Chemistry** 1.1.1 Simple structures Structures of AB type compounds (PbO and CuO), AB_2 type (β cristobalite, CaC_2 and Cs_2O), A_2B_3 type (Cr_2O_3 and Bi_2O_3), AB_3 (ReO_3, Li_3N), ABO_3 type, relation between ReO_3 and perovskite $BaTiO_3$ and its polymorphmic forms, Oxide bronzes, ilmenite structure, AB_2O_4 type, normal, inverse, and random spinel structures. 1.1.2 Linked Polyhedra (i) Corner sharing: tetrahedral structure (Silicates) and octahedral structure (ReO_3) and rotation of ReO_3 resulting in VF_3, RhF_3 and calcite type structures. (ii) Edge sharing: tetrahedral structures (SiS_2) and octahedral structures (BiI_3 and $AlCl_3$). pyrochlores, octahedral tunnel structures and lamellar structures.	**15L**
2	**1.2 Imperfection in crystals and Non-Stoichiometry** 1.2.1 Point defects: Perfect and imperfect crystals, intrinsic and extrinsic defects- point, line and plane defects, Point defects in metals and ionic Crystal – Frenkel defect and Schottky defect. Thermodynamics formation of these defects (mathematical derivation to find defect concentration); Defects in non- Stoichiometric compounds, colour centers. 1.2.2 Line defects: Edge and Screw Dislocations. Mechanical Properties and Reactivity of Solids.	**15L**

	1.2.3 Surface Defects: Grain Boundary and Stacking Fault. Dislocation and Grain Boundaries, Vacancies and Interstitial Space in Non-Stoichiometric Crystals, Defect Clusters, Interchangeable Atoms and Extended Atom Defects.	
3	**1.3 Methods of Preparations** 1.3.1 Methods of Synthesis: Chemical Method, High Pressure Method, Arc Technique and Skull Method (with examples). 1.3.2 Different methods for single crystal growth: (i) Crystal Growth from Melt–: a) Bridgman - vertical and horizontal technique, b) Stockbargar, c) Czochralski - Growth and characterization of silicon multicrystal for solar cell application and d) Vernuil methods, advantages and disadvantages of all methods (ii) Crystal growth from liquid solution: Flux growth and temperature gradient methods (iii) Crystal growth from vapor phase: – Epitaxial growth methods. 1.3.3 Thin film preparation: Physical and Chemical methods. 1.3.4 Solid Solutions: Formation of Substitutional, Interstitial and Complex Solid Solutions; Mechanistic Approach; Study of Solid solutions by X-ray Powder Diffraction and Density Measurement.	**15L**
4	**1.4 Behavior of Inorganic Solids** 1.4.1 Diffusion in Solids: Fick's Laws of Diffusion; Kirkendal Effect; Wagner mechanism, Diffusion and Ionic Conductivity; Applications of Diffusion in Carburizing and non-Carburizing Processes in Steel Making. 1.4.2 Solid state reactions: General principles and factors influencing reactions of solids, Reactivity of solids. 1.4.3 Liquid Crystals: Introduction and classification of thermotropic liquid crystals, Polymorphism in liquid crystal, Properties, Photoconducting discotic liquid crystals and applications of liquid crystals.	**15L**
	Total	**60L**
PRACTICALS		
Analysis of ores/alloys 1) Analysis of Brass alloy: (i) Cu content by iodometric method, (ii) Zn content by complexometric method. 2) Analysis of Mangelium alloy: (i) Al content by gravimetric method as basic succinate, (ii) Mg content by complexometric method. 3) Analysis of Bronze alloy: (i) Cu content by complexometric method, (ii) Sn content by gravimetric method. 4) Analysis of steel nickel alloy: (i) Ni content by homogeneous precipitation method.		

REFERENCE BOOKS

1. Smart, L. E.; Moore, E. A. *Solid State Chemistry-An introduction*; Taylor and Francis, 2005.
2. West, A. R. *Solid State Chemistry and its Applications*; John Wiley & Sons: New York, 1987.
3. Rao, C. N. R.; Gopalkrishnan, J. *New Directions in Solid State Chemistry*; Cambridge University Press. 1997.
4. Azaroff, L.V. *Introduction to Solids;* McGraw Hill Book: New Delhi, 1977.
5. Bruce, D.W.; Hare, D. O. *Inorganic Chemistry*; John Wiley & Sons: New York, 1966.
6. Hollas, J. M. *Symmetry in Molecules;* Chapman and Hall: London, 1972.
7. Carter, R. L. *Molecular Symmetry and Group Theory*; John Wiley & Sons: New York, 1988.
8. Muller, U. *Inorganic Structural Chemistry;* John Wiley & Sons, 1993.
9. Kutty, TRN; Tareen, JAK *Fundamentals of Crystal Chemistry*; Universities Press: India, 2001.
10. Keer, H. V. *Principles of the Solid State*; New Age International Publishers, 1993.
11. Miessler, G. L.; Tarr, D. A. *Inorganic Chemistry;* Pearson Education, 2004.
12. Chakraborty, D. K. *Solid State Chemistry;* New Age International Publishers, 1996.
13. Earnshaw, A. *Introduction to Magnetochemistry;* Academic Press, 1966.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Inorganic Chemistry)				**Semester : III**	
Course : Bioinorganic and Coordination Chemistry				**Course Code: PSMACHI302**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Course Objectives:

Metal ion plays a vital role in a vast number of widely differing biological processes. The role played by metal ions in bio-molecules has been considered as fascinating phenomenon by coordination chemist. The aim of this course is to understand the role of metal ions in a few key metalloproteins and biological processes. It helps understand the group characteristics of Lewis acids and applications of acid-base chemistry. It describes the structure, bonding and stereochemistry of Coordination compounds.

Course Outcomes:

After completion of the course, students would be able to :

CO1: Understand the different structural forms of crystals with adequate examples.
CO2: Explain the linked polyhedral and types of sharing involved.
CO3: Describe the point defects in stoichiometric and non-stoichiometric compounds.
CO4: Find defect concentration by using mathematical derivations.
CO5: Synthesize inorganic solids using single crystal growth methods.
CO6: Classify liquid crystals and also understand their properties and applications.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**2.1 Bioinorganic Chemistry** 2.1.1 Coordination geometry of the metal ion and functions. 2.1.2 Zn in biological systems: Carbonic anhydrase, protolytic enzymes, e.g. carboxy peptidase, Zinc finger. 2.1.3 Role of metal ions in biological electron transfer processes: iron sulphur proteins, 2.1.4 Less common ions in biology e.g. Mn (arginase; structure and reactivity), Ni (urease; structure and reactivity) 2.1.5 Bio mineralization 2.1.6 Metal complexes as drugs: Pt, Rh, Ru and Au drugs. 2.1.7 Toxic effects of metal ions, detoxification by chelation therapy.	**15L**
2	**2.2 Reactivity of Chemical Species –I** 2.2.1 Recapitulation of the definition of Lewis acids and bases, Classification of Lewis acids and bases based on frontier Molecular orbital topology, Reactivity matrix of Lewis acids and bases. 2.2.2 Group Characteristic of Lewis acids (Gp-1,13-17). 2.2.3 The fundamental types of reactions 2.2.4 Pauling rules to determine the strength of oxoacids; classification and Structural anomalies.	**15L**

3	**2.3 Reactivity of Chemical Species –II** 2.3.1 Pourbaix Diagrams. 2.3.2Amphoteric behavior, Periodic trends in amphoteric properties of p-block and d-block elements 2.3.3 Oxoanions and Oxocations 2.3.4 Measures of hardness and Softness of Acids and Bases, Drago-wayland equations 2.3.5 Applications of acid-base Chemistry: Super acids and Super bases, heterogeneous acid-base reactions.	**15L**
4	**2.4 Structure, Bonding, and Stereochemistry of Coordination Compounds** 2.4.1 Structure and Bonding. i) Molecular Orbital Theory for Complexes with Coordination Number 4 and 5 for the central ion (sigma as well as Pi bonding) (ii) Angular Overlap Model for octahedral and tetrahedral complexes for sigma and pi bond. 2.4.2 Stereochemistry of Coordination Compounds. (i) Chirality and Fluxionality of Coordination Compounds with Higher Coordination Numbers. (ii) Geometries of Coordination compounds from Coordination number 6 to 9.	**15L**
	Total	**60L**
PRACTICALS		
Solvent Extraction 1) Separation of Mn and Fe using isoamyl alcohol and estimation of Mn 2) Separation of Co and Ni using n-butyl alcohol and estimation of Co 3) Separation of U and Fe using 8-hydroxyquinoline in chloroform and estimation of U 4) Separation of Fe and Mo using isoamyl alcohol and estimation of Mo Separation of Cu and Fe using n-butyl acetate and estimation of Cu		

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Program: Master of Science (Inorganic Chemistry)				**Semester : III**	
Course : Spectral Methods in Inorganic Chemistry				**Course Code: PSMACHI303**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Course Objectives:

Metal ion plays a vital role in a vast number of widely differing biological processes. The role played by metal ions in bio-molecules has been considered as fascinating phenomenon by coordination chemist. The aim of this course is to understand the role of metal ions in a few key metalloproteins and biological processes. It helps understand the group characteristics of Lewis acids and applications of acid-base chemistry. It describes the structure, bonding and stereochemistry of Coordination compounds.

Course Outcomes:

After completion of the course, students would be able to :

CO7: Understand the different structural forms of crystals with adequate examples.
CO8: Explain the linked polyhedral and types of sharing involved.
CO9: Describe the point defects in stoichiometric and non-stoichiometric compounds.
CO10: Find defect concentration by using mathematical derivations.
CO11: Synthesize inorganic solids using single crystal growth methods.
CO12: Classify liquid crystals and also understand their properties and applications.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**3.1 Diffraction Methods –I** X-Ray Diffraction: Direct and Reciprocal lattice; Miller Indices; Braggs equation; Laue equation; Experimental Diffraction methods: Powder Diffraction, Debye Scherrer Method and Laue method; Indexing and determination of lattice type and unit cell dimensions of cubic crystals; Crystallite size	**15L**
2	**3.2 Diffraction Methods –II** 3.2.1 **Electron Diffraction:** Scattering of electrons, Magnetic Scattering; Importance of neutron scattering; Advantages and Disadvantages; Instrumentation, Scattering Intensity versus Scattering Angle, Weirl Measurement Technique, and Elucidation of Structures of Simple gas Phase Molecules. 3.2.2 **Neutron Diffraction:** Scattering of Neutrons: Scattering of neutrons by Solids and Liquids, Magnetic Scattering, Measurement Technique.	**15L**
3	**3.3 Electron Spin Resonance Spectroscopy** 3.3.1 Electron behavior, interaction between electron spin and magnetic field. 3.3.2 Instrumentation: Source, Sample cavity. Magnet and Modulation coils, Microwave Bridge, Sensitivity. 3.3.3 Relaxation processes and Line width in ESR transitions: (i) ESR relaxation and chemical bonding. (ii) Interaction between nuclear spin and electron spin (hyperfine coupling)	**15L**

	(iii) Spin polarization for atoms and transition metal ions, (iv) Spin-orbit coupling and significance of g-tensors, (v) Application to transition metal complexes (having one unpaired electron)	
4	**3.4 Mössbauer Spectroscopy:** 3.4.1 Basic principle, recoil energy and Doppler shift. 3.4.2 Instrumentation: sources and absorber; motion devices, detection, reference substances 3.4.3 Isomer shift, quadrupole interaction, magnetic interaction, electronegativity and chemical shift. 3.4.4 Applications in structure determination of transition metal compounds and complexes	**15L**
	Total	**60L**
PRACTICALS		
Inorganic Preparations 1. Preparation of $V(oxinate)_3$ 2. Preparation of Sn(IV) Iodide 3. Preparation of $Co(\alpha\text{-nitroso-ß-naphthol})_3$ 4. Preparation of $Ni(salicylaldoxime)_2$ 5. Hexaamine cobalt (III) chloride 6. Preparation of Trans-bis (glycinato) Cu(II)		

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Program: Master of Science (Inorganic Chemistry)				**Semester : III**	
Course : Applied Chemistry (Elective)				**Course Code: PSMACHI304**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical** (Hours per week)	**Tutorial** (Hours per week)	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Course Objectives:

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Outcomes:

After completion of the course, students would be able to:

CO1: Understand classification, manufacture and applications of Inorganic fibres, Inorganic fillers
CO2: Study of condensed phosphates and coordination polymers
CO3: Preparation, properties and uses of industrially important chemicals
CO4: Understand nuclear fuels and their separation methods
CO5: Explain discovery, preparation and position in the periodic table of super heavy elements.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**4.1 Inorganic Materials** 4.1.1 Classification, manufacture and applications of (i) Inorganic fibers (ii) Inorganic fillers: Study of Condensed phosphates and Coordination polymers. 4.1.2 Preparation, properties and uses of industrially important chemicals – potassium permanganate, sodium thiosulphate, bleaching powder, hydrogen peroxide, potassium dichromate.	**15L**
2	**4.2 Nuclear Chemistry and Inorganic Pharmaceuticals** 4.2.1 Nuclear Chemistry: Introduction to of nuclear fuels and separation of fission products from spent fuel rods by PUREX process. Super heavy element, discovery, preparation, position in the periodic table. 4.2.2 Inorganic Pharmaceuticals: Radiopharmaceuticals containing Tc and Bi, contrast agents for X-ray and NMR imaging. Gasrtrointestinal agents viz. (i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate, aluminium phosphate and (ii) Cathartics (magnesium sulphate and sodium phosphate). Topical agents viz. (i) protectives and adsorbents (talc, calamine), (ii) antimicrobial agents (potassium permanganate, tincture iodine, boric acid) and astringents (potash alum).	**15L**
3	**4.3 Advances in Nanomaterials** 4.3.1 Types of nanomaterials, e.g. nanotubes, nanorods, solid spheres, core-shell nanoparticles, mesoporous materials; isolation of nano materials	**15L**

	4.3.2 Some important properties of nanomaterials: optical properties of metal and semiconductor nanoparticles, magnetic properties. 4.3.3 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. Graphene: Introduction and applications. 4.3.4 Applications of nanomaterials in electronics, energy, automobiles, sports and toys, textile, cosmetics, medicine, space and defense. Environmental effects of nanotechnology	
4	**4.4 Some Selected Topics** 4.4.1 Isopoly and Hetropoly acids 4.4.2 Supramolecular chemistry - Chiral recognition by Crown Ethers, Macrocyclic polyamines- Nitrogen based cyclic hosts, Molecular recognition at interface 4.4.3 Inorganic pesticides 4.4.4 Intercalation compounds	**15L**
	Total	**60L**
PRACTICALS		
Analysis of the following samples: 1. Calcium tablet for its calcium content by complexometric titration. 2. Bleaching powder for its available chlorine content by iodometric method. 3. Iron tablet for its iron content colorimetry by 1,10-phenonthroline method. 4. Calcium tablet for its calcium content by complexometric titration. 5. Nycil powder for its Zn content complexometrically.		

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UNIVERSITY OF MUMBAI

Program: M. Sc. (Inorganic Chemistry)

Semester IV

Credit Based Choice System (CBCS) with effect from the Academic year 2020-21

PROGRAMME SPECIFIC OUTCOMES (PSO'S)

On completion of the M.Sc. Inorganic Chemistry, the learners should be enriched with knowledge and be able to-

PSO1: Qualify the national and state level entrance exams such as CSIR-NET, SET, GATE for pursuing Ph.D.

PSO2: Apply advanced concepts in inorganic chemistry to solve complex chemical problems.

PSO3: Design experiments, analyse, synthesize and interpret data to provide solutions to different industrial problems by working in the pure, inter and multi-disciplinary areas of chemical sciences.

PSO4: Able to independently carry out research in the areas related to materials, coordination compounds, catalysis and nanotechnology

Preamble

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c) Details of Continuous Assessment (CA)

25% of the total marks per course:

Continuous Assessment	Details	Marks
Component 1 (CA-1)	Test	15 marks
Component 2 (CA-2)	Assignment	10 marks

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75% of the total marks per course. Duration of examination will be two and half hours.

Question Number	Description	Marks	Total Marks
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Q.2	Answer any four out of five	05	20
Q.3	Answer any four out of five	05	20
Q.4	Answer any four out of five	05	20
Q.5	Answer any three out of four	05	15
		Total Marks	**75**

Signature Signature Signature

HOD Approved by Vice –Principal Approved by Principal

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Inorganic Chemistry)				**Semester : IV**	
Course : Properties of Inorganic Solids and Group Theory				**Course Code: PSMACHI401**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Course Objectives:

This course aims at providing the students with a thorough information about the various properties of materials/solids. It introduces important materials such as ion conductors, perovskites, Ilmenites, phosphors, plumbites which have immense applications in industries.

Course Outcomes:

After completion of the course, students would be able to :

CO7: Explain the conduction mechanism in solid conductors such as fast ion conductors

CO8: Explain the various electrical effects exhibited by solids such as Thomson effect, Seebeck effect, Hall Effect

CO9: Understand the magnetic behavior of solids in magnetic field

CO10: Explain the properties of various magnetic materials such as perovskites, magneto plumbites, etc.

CO11: Describe the thermal and optical properties in solids

CO12: Classify molecules based on their symmetry

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**1.1 Electrical Properties** 1.1.1 Electrical properties of solids: Conductivity: Solid Electrolytes; Fast Ion Conductors; Mechanism of Conductivity; Hopping Conduction, Conductivity in β-alumina, Nasicon, Hollandites and Priderites; Effect of impurities in the conductivity of AgCl and NaCl. 1.1.2 Other Electrical Properties Thomson and Seebeck Effects; Thermocouples and their Applications; Hall Effect; Dielectric, Ferroelectric, Piezoelectric and Pyroelectric Materials and their Inter-relationships and Applications.	**15L**
2	**1.2 Magnetic Properties** 1.2.1 Behavior of substances in magnetic field, Curie and Curie-Weiss law, mechanism of ferromagnetic and antiferromagnetic ordering, super exchange, Hysteresis, Hard and soft magnets, structures, Pauli Paramagnetism 1.2.2 Magnetic Properties of Metals and Alloys; Transition metal Oxides; Spinels; garnets, Ilmenites; Perovskite and Magneto plumbites and YIG 1.2.3 Application in transformer cores, information storage and as permanent magnets.	**15L**
3	**1.3 Thermal and Optical Properties** 1.3.1 Thermal Properties: Introduction, Heat Capacity and its Temperature Dependence; Thermal Expansion of Metals; Ceramics and Polymers and Thermal Stresses. 1.3.2 Optical properties: Color Centers, F-centers; Luminescent and Phosphor	**15L**

	Materials; Coordinate Model; Phosphor Model; Anti Stokes Phosphor; Ruby Laser; Neodymium Laser.	
4	**1.4 Applications of group theory to Electronic structures** 1.4.1 Recapitulation of Points groups and Character tables 1.4.2 Symmetry and selection rules: Symmetry properties of common orbitals. 1.4.3 Application of character tables to infrared and Raman spectroscopy. Infrared and Raman active modes for C_{2v}, C_{3v} and D_{4h} added 1.4.4 Transformation Properties of Atomic Orbitals 1.4.5 Sigma and pi- molecular orbitals for AB_4 (tetrahedral) and AB_6 (octahedral) molecules 1.4.6 Ligand Field Theory : Electronic structures of free atoms and ions; Splitting of levels and terms in a chemical environment; Construction of energy level diagrams; Direct product ; Correlation diagrams for d^2 ions in octahedral and tetrahedral ligand field; Methods of Descending Symmetry; Hole formalism.	**15L**
	Total	**60L**
PRACTICALS		
Analysis of Ores 1. Analysis of galena ore: (i) Pb content as $PbCrO_4$ by gravimetric method using 5% potassium chromate (ii) Fe content by colorimetrically using 1, 10- phenonthroline 2. Analysis of Zinc blend ore: (i) Zn content by complexometric method (ii) Fe content by colorimetric method (Azide method) 3. Analysis of Pyrolusite ore: (i) Mn content by complexometric method (ii)Acid insoluble residue by gravimetric method		

REFERENCE BOOKS

1. Smart, L. E.; Moore, E. A. *Solid State Chemistry-An introduction*; Taylor and Francis, 2005.
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Program: Master of Science (Inorganic Chemistry)				**Semester : IV**	
Course : Organometallics and main group Chemistry				**Course Code: PSMACHI402**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Objectives:

The course aims to provide the students with a thorough understanding of the relationship between the structures, chemical bonds and chemical properties in organometallic chemistry. The course notably contains an extensive knowledge of transition metal complexes, particularly aimed at catalysis. The course also introduces students to metal clusters, boranes, inorganic ring and chain compounds.

Outcomes:

After completion of the course, students would be able to :

CO13: explain the bonding in metal complexes and clusters
CO14: calculate the electron count in clusters
CO15: Understand the preparation, properties and applications of organo palladium and platinum complexes
CO16: Apply organometallic compounds as catalysts in organic reactions
CO17: classify clusters and different structural patterns of metal clusters
CO18: understand the bonding in boranes
CO19: understand different types of inorganic ring and chain compounds such as silicates, polysilicates and aluminosilicates, phosphazenes, phosphazene polymers, polyanionic and polycationic compounds

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**2.1 Organometallic Chemistry** 2.1.1 Metal-Metal Bonding and Metal Clusters 2.1.2 Electron Count and Structures of Clusters 2.1.3 Isolobal Analogy 2.1.4 Organo Palladium and Organo Platinum Complexes (preparations, properties and applications.) 2.1.5 Reactions of organometallic complexes: substitution, oxidative addition, reductive elimination, insertion and elimination, electrophilic and nucleophilic reactions of coordinated ligands	**15L**
2	**2.2 Applications of Organometallic Compounds** 2.2.1 Catalysis-Homogenous and Heterogenous Catalysis: Comparison, Fundamental Reaction Steps. 2.2.2 Organometallics as Catalysts in Organic Reactions: (i) Hydrosilation (ii) Hydroboration. (iii) Water gas Shifts Reaction (iv) Wacker process(Oxidation of alkenes) (v) Alcohol carbonylation	**15L**

	(vi) Asymmetric hydrogenation (vii) Metathesis (vii) Hydroformylation (viii) Ziegler Natta catalysis 2.2.3 Coupling reactions: (i) Heck reaction (ii) Suzuki reaction	
3	**2.3 Inorganic cluster and cage compounds** 2.3.1 Introduction of cage compounds 2.3.2 Bonding in boranes 2.3.3 Wade's rules 2.3.4 Application of Wade's rules 2.3.5 Isolobal Principle 2.3.6 Heteroboranes 2.3.7 Carboranes 2.3.8 Cluster compounds 2.3.9 Cluster compounds in catalysis 2.3.10 Electron precise compounds and their relation to clusters.	**15L**
4	**2.4 Inorganic ring and chain compounds** 2.4.1 Silicates, polysilicates and aluminosilicates 2.4.2 Phosphazenes, phosphazene polymers 2.4.3 Polyanionic and polycationic compounds 2.4.4 Silicones 2.4.5 Sulphur-Nitrogen cyclic compounds	**15L**
	Total	**60L**
PRACTICALS		
Coordination Chemistry 1. Determination of Stability constant of $[Zn(NH_3)_4]^{2+}$ by potentiometry 2.Determination of Stability constant of $[Ag(en)]^{+}$ by potentiometry 3. Determination of Stability constant of $[Fe(SCN)]^{2+}$ by slope ratio method 4. Determination of CFSE values of hexa-aqua complexes of Ti^{3+} and Cr^{3+} 5. Determination of Racah parameters for complex $[Ni(H_2O)_6]^{2+}$ and $[Ni(en)_3]^{2+}$		

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SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: Master of Science (Inorganic Chemistry)				**Semester : IV**	
Course : Instrumental methods in Inorganic Chemistry				**Course Code: PSMACHI403**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Objectives:

Students will explore to Instrumental methods in Inorganic Chemistry Infrared spectroscopy and Raman spectroscopy Raman spectroscopy for diatomic molecules. Applications of Group theory in Infrared and Raman spectroscopy. Molecular Vibrations: Introduction; Nuclear Magnetic Resonance Spectroscopy Introduction to basic principles and instrumention. Introduction to surface spectroscopy, Microscopy, problems of surface analysis, distinction of surface species, sputter etching and depth profile and chemical imaging, instrumentations, Ion Scattering Spectra (ISS), Secondary Ion Mass Spectroscopy (SIMS), Auger Emission Spectroscopy (AES) ESCA, Scanning Electron Microscopy (SEM), Atomic force microscopy (AFM) and transmission electron microscopy (TEM): Instrumentation and applications Application of TGA . Application of DSC and DTA in determination of thermodynamic parameters such as heat capacity and standard enthalpy of formation of the compounds, investigation of phase transitions, thermal stability of polymeric materials, purity of pharmaceuticals samples, M.P. and B.P. of organic compounds etc. Basic principle, instrumentation and applications to other thermal methods like Thermomechanical analysis (TMA) and evolved gas analysis (EGA).

Outcomes:

After completion of the course, students would be able to:

CO1: To understand instrumental methods in Inorganic Chemistry Infrared spectroscopy and Raman spectroscopy Raman spectroscopy for diatomic molecules.

CO2: To apply Group theory in Infrared and Raman spectroscopy.

CO3: To understand molecular Vibrations

CO4: To introduce instruments for study of surfaces

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Instrumental methods in Inorganic Chemistry.** **3.1 Spectroscopy** 3.1.1 Infrared spectroscopy: Fundamental modes of vibrations, selection rules, IR absorption bands of metal - donor atom, effect of complexation on the IR spectrum of ligands formations on the IR of ligands like NH_3, CN^-, CO, olefins (C=C) and $C_2O_4^{2-}$ 3.1.2 Raman spectroscopy: Raman spectroscopy for diatomic molecules. Determination of molecular structures like diatomic and triatomic molecules. (c) Applications of Group theory in Infrared and Raman spectroscopy. (c) Molecular Vibrations: Introduction; The Symmetry of Normal Vibrations; Determining the Symmetry Types of the Normal Modes; symmetry based Selection Rules of IR and Raman; Interpretation of IR and Raman Spectra for molecules such as H_2O, BF_3, N_2F^2, NH_3 and CH_4. Use of FTIR and Raman spectroscopy for characterization of nanomaterials. 3.1.3 Nuclear Magnetic Resonance Spectroscopy: Introduction to basic principles and instrumentation. Use of ^1H, ^{19}F, ^{31}P, ^{11}B NMR spectra in structural elucidation of	**15L**

	inorganic compounds; Spectra of paramagnetic materials: Contact shift, application of contact shift, lanthanide shift reagent.	
2	**3.2 Microscopy of Surface Chemistry-I** Introduction to surface spectroscopy, Microscopy, problems of surface analysis, distinction of surface species, sputter etching and depth profile and chemical imaging, instrumentations, Ion Scattering Spectra (ISS), Secondary Ion Mass Spectroscopy (SIMS), Auger Emission Spectroscopy (AES), Energy Dispersive X-ray Analysis to identify the elements composition of Material and its application in material research troubleshooting.	**15L**
3	**3.3 Microscopy of Surface Chemistry-II** ESCA, Scanning Electron Microscopy (SEM), Atomic force microscopy (AFM) and transmission electron microscopy (TEM): Instrumentation and applications.	**15L**
4	**3.4 Thermal Methods** 3.4.1 Application of TGA in Thermal characterization of polymers, quantitative analysis of mixture of oxalates, moisture content in coal, study of oxidation state of alloys, etc. 3.4.2 Application of DSC and DTA in determination of thermodynamic parameters such as heat capacity and standard enthalpy of formation of the compounds, investigation of phase transitions, thermal stability of polymeric materials, purity of pharmaceuticals samples, M.P. and B.P. of organic compounds, etc. 3.4.3 Basic principle, instrumentation and applications to other thermal methods like Thermomechanical analysis (TMA) and evolved gas analysis (EGA).	**15L**
	Total	**60L**
PRACTICALS		
Analysis of the following samples: 1) Electral powder for Na/K content flame by flame photometry. 2) Fasting salt for chloride content by conductometry. 3) Sea water for percentage salinity by Volhard's method. 4) Soil for mixed oxide content by gravimetric method. 5) Fertilizer for potassium content by flame photometry.		

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28. House, J. E. *Inorganic Chemistry;* Academic Press, 2013.

SVKM's Mithibai College of Arts, Chauhan Institute of Science & Amrutben Jivanlal College of Commerce & Economics (AUTONOMOUS)

Program: M. Sc. Inorganic Chemistry				**Semester : IV**	
Course : Research Methodology				**Course Code: PSMACHI404**	
Teaching Scheme				**Evaluation Scheme**	
Lecture (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment and Evaluation (CAE) (Marks - 25)**	**Term End Examinations (TEE) (Marks- _____ in Question Paper)**
04	04	-	04+02	10+15	75

Learning Objectives:

The objective of the course is to introduce students to importance of,

1. Research journals and webs.
2. Data Analysis.
3. Various methods scientific research
4. Chemical safety& ethical handling of chemicals.

Learning Outcomes:

After completion of the course, students would be able to know about:

CO1: Various sources of information like print and digital sources, importance of chemical abstract.
CO2: Data analysis and its different method.
CO3:3. How to do referencing and to write a scientific research paper.
CO4: Chemical safety and handling of chemicals.

Outline of Syllabus: (per session plan)

Module	**Description**	**No of Hours**
1	**Print: Primary, Secondary and Tertiary sources** Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, textbooks, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. Digital:Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	**15L**
2	**Data Analysis** The Investigative Approach: Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. Analysis and Presentation of Data: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	**15L**

3	**Methods of scientific research and writing scientific papers** Reporting practical and project work, writing literature surveys and reviews, organizing a poster display, giving an oral presentation. Writing Scientific Papers: Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.	**15L**
4	**Chemical safety & ethical handling of chemicals** Safe working procedure and protective environment, protective apparel, emergency procedure, first aid, laboratory ventilation, safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric pressure, safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**15L**
	Total	**60L**
PRACTICALS		
Project		