Kadi Sarva Vishwavidhyalaya

M.Sc. Chemistry

Syllabus

(Inorganic Chemistry)

Sem III and Sem IV

w.e.f. June 2018

KADI SARVA VISHWAVIDYALAYA
M. Sc Inorganic Chemistry Semester – 3 & 4 Syllabus Structure
(W.E.F. June 2018)

	KADI SARVA VISHWAVIDYALYA					
	M.SC INORGANIC CHEMISTRY SEMESTER-3 SCHEME					
Subject Code	**Course**	**Instruction Hrs / week**	**Examination**			**Credit**
			Internal	**University Exam**	**Total**	
CH-IC 301	Molecular Spectroscopy	4	30	70	100	4
CH-IC 302	Applied Inorganic Chemistry	4	30	70	100	4
CH-IC 303	Chemistry of Metals	4	30	70	100	4
CH-IC 304	Supramolecular and Photo-inorganic chemistry	4	30	70	100	4
CC-301 A	Research Methodology I	2	15	35	50	2
CH-IC 305	Inorganic chemistry Practicals - I	16	0	200	200	8
	Total	**34**	**135**	**515**	**650**	**26**

	KADI SARVA VISHWAVIDYALYA					
	M.SC INORGANIC CHEMISTRY SEMESTER - 4 SCHEME					
Subject Code	**Course**	**Instruction Hrs / week**	**Examination**			**Credit**
			Internal	**University Exam**	**Total**	
CH-IC 401	Modern trends in Bio-inorganic chemistry	4	30	70	100	4
CH-IC 402	Nano materials and Instrumental analysis	4	30	70	100	4
CC-401 A	Research Methodology II	2	15	35	50	2
CH-IC 403	Inorganic Chemistry Practicals - II	8	0	100	100	4
CH-IC 404	Dissertation / Industrial Training	12	50	250	300	12
	Total	**30**	**125**	**525**	**650**	**26**

KADI SARVA VISHWAVIDYALYA
M.Sc In-Organic Chemistry Syllabus

Semester III

Paper: Molecular Spectroscopy (CH-IC 301)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 301	Molecular Spectroscopy	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of molecular spectroscopy. To understand various molecular transitions and hence the spectra arising on the basis of transitions between different energy levels.

Learning Outcome:

- Students can understand different concepts of rotational and vibrational spectroscopy
- They can understand the fundamental principles of molecular transitions between various energy level arising due to incidence of different electromagnetic radiations.
- They can understand the principle and instrumentation of raman spectroscopy
- Students can gain knowledge of electronic spectroscopy and application of ESR spectroscopy.

Unit	Topics of Paper CH-IC 301	Marks	Teaching Hrs
	Section A		
1	**Microwave Spectroscopy (Rotational Spectroscopy)** Basics of spectroscopy. The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear molecules and symmetric top molecules. Applications of microwave spectroscopy.	15	15
2	**Infrared Spectroscopy (vibrational Spectroscopy)** The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P,Q,R branches, vibration of polyatomic molecules, normal mode of vibrations.	15	15
	Section B		
3	**Raman Spectroscopy** Classical and quantum theories, pure rotational Raman spectra of linear molecules and symmetric top molecules, vibrational Raman spectra, mutual exclusion principle, overtone and combination vibrations, polarization of the light and Raman effect, depolarization of Raman lines. instrumentation and applications of Raman spectroscopy.	15	15

4	**Electronic Spectroscopy** Electronic Spectra of Diatomic molecules, Frank-condon principle, Rotational fine structure of Electronic Vibrational Transition, Electronic Structure of diatomic molecules (Molecular orbital theory, Shapes of Molecular orbitals, electronic angular moment in diatomic molecules) **Electron Spin Resonance Spectroscopy** Basic principles of ESR, experimental technique, the g-value hyperfine structure, Instrumentation of ESR and its applications to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.	15	15
	Objective questions from all units	10	

Reference books:

1. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata McGraw Hill.
2. Modern Spectroscopy, J.M. Hollas, John Wiley.
3. Basic Principles of Spectroscopy, R.Chang, McGraw Hill.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
5. Physical Method in Chemistry, R.S. Drago, Saunders College.

Paper: Applied Inorganic Chemistry (CH-IC 302)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 302	**Applied Inorganic Chemistry**	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of Applied Inorganic Chemistry. To understand chemistry of transition and non-transition elements and their materials.

Learning Outcome:

- Students can understand different concepts of non-transition elements.
- They can understand the fundamental principles of Zeolite.
- They can understand the various synthetic methods of Zeolite.
- Students can gain knowledge of characterizing techniques for Zeolite.

Unit	Topics of Paper CH-IC 302	Marks	Teaching Hrs
	Section A		
1	**Chemistry of Non-Transition Elements** Synthesis, Properties and structure of boranes, Carboranes, borazines, silicates, carbides, silicones, phosphazenes, sulphur nitrogen compounds, phosphorous cyclic compounds and noble gas compounds, Iso and hetropoly acids	15	15
2	**Basic concept of zeolites** Introduction, definition, classifications on the basis of morphological appearance, SBU,substitution of other iso-electronic metal ions, types of pore size. Lowenstein's rule. pore andchannels, channel dimensions, shape of the pore opening, nomenclature of zeolites, structuralaspect of zeolites, acidity of zeolite, identification of acidic sites, nature of active sites,synergetic effects, shape selectivity.	15	15
	Section B		
3	**Synthesis of zeolites** General methods for synthesis of zeolite, hydrothermal treatment, mechanism of aluminosilicate formation during Sol-Gel, co-precipitation process, factors affecting the zeolite formation. Modification of zeolites, Oswald's rules of successive transformation, crystallization and its identification, factors affecting crystallization, template theory, organic additives, crystallizing zeolites, ZSM-5 from an organic free solvent system, synthesis in non-aqueous solvents.	15	15

4	**Characterization and applications of zeolite** General characterization techniques for analysis of zeolites, Details on FTIR, Pyridine adsorbed- IR analysis, XRD analysis, 27Al MAS NMR and 29 Si MAS NMR analysis, Temperature programmed desorption (TPD), probe molecules for TPD analysis, NH3- TPD and CO2- TPD. Applications of zeolite, Zeolite catalysed reactions, water softening.	15	15
	Objective questions from all units	10	

Reference books:

1. Molecular sieves: Principles of synthesis and Identifications R-Szostak.
2. Atlas of zeolite framework type; Ch. Barlocher, W M. Meier, D. H. Olson; 5th rev. Ed. Elsevier Amsterdam 2001
3. Molecular Sieves Science and Technology vol I & II, H G Karge, J Weitkamp- Springer
4. Molecular Sieves Science and technology; H. G. Karge, J Weitkamp Vol I to V, Springer
5. Industrial catalyst- A Practical Approach, Jens Hygen, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany
6. Stoichometry (SI Units): B.I. Bhatt & S.M. Vora.
7. Heterogeneous Catalysis and Solid Catalysts, Olaf Deutschmann, Helmut Knozinger, Karl
Kochloefl, Thomas Turek, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim
8. Green chemistry and catalysis – Roger A. Sheldon, Isabel Arends, Ulf Hanefeld. WileyVCH

Paper: Chemistry of Metals (CH-IC 303)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 303	Chemistry of Metals	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of various metal clusters. To understand differentstability of the metal clusters by using EAN rule. They could also learn the fundamental of catalysis.

Learning Outcome:

- Students can understand chemistry of Metal Carbonyls and their EAN rule.
- They can understand the fundamental Metal Nitrosyls and their importance.
- They can understand the principle for the synthesis of metal clusters.
- Students can gain fundamental knowledge of catalysis.

Unit	Topics of Paper CH-IC 303	Marks	Teaching Hrs
	Section A		
1	**Chemistry of Metal Carbonyls** Classification; Chemistry of carbonyl group Preparation, properties, structures and bonding in iron carbonyls, Ni(CO)4, Co2(CO)8, Mn2(CO)10, Cr(CO)6, Mo(CO)6 and W(CO)6, Co4(CO)12 and V(CO)6. EAN rule applied to these carbonyls structures of mixed carbonyls of transition metals and EAN rule applied to these carbonyls. Preparations carbonyl halides	15	15
2	**Metal nitrosyl compounds** Preparations and properties of Nitrosyl halides (NOX), Metal nitrosyl halides, compounds containing NO- group, Compounds containing NO+ groups, Preparation, structure and application of sodium Nitropruside. EAN and Eighteen electron rules applied to: Nitrosyl compounds of Cobalt, iron and Manganese. Significance of NO for the life of living animal	15	15
	Section B		
3	**Chemistry of dioxygen, dinitrogen complexes and non-carbonyl metal clusters** **A**. Preparation structure and function of Cobalt dioxygen complexes. Preparation, properties, structures and function of dinitrogen complexes of Molybdenum, Structures and function of nitrogenase enzymes. **B.** Preparation, structure and bonding in Non-carbonyl metal clusters viz. Binuclear (Re2Cl8)2-, Trinuclear ('ReCl3)3, Tetranuclear (W4(OR)6) and Hexanuclear (Mo6Cl6)4+ ions. Preparation, properties and structures of Zintl anions & cation of Ge, Sn, and Bi	15	15

4	**Fundamentals of catalysis** Catalysis, types of catalysis, catalyst, properties of catalyst, classification of catalysts, Sabtier'sprinciple, classification of solid catalysis, fundamentals of heterogeneous catalysis, factor affecting the catalyst performance, promoters, types of promoters, Inhibitors, catalyst poisoning, overview on heterogeneously catalyzed process in industry.	15	15
	Objective questions from all units	10	

Reference books:

1. Inorganic Chemistry, J.E. Hubeey, E.A. Keitler, R.L. Keitler.
2. Concise Inorganic Chemistry, J.D. Lee.
3. Inorganic electronic spectroscopy, A.B.P. Lever.
4. Symmetry and Spectroscopy of Molecules, K. Veera Reddy
5. Symmetry and Group theory in Chemistry, R Ameta
6. Inorganic Chemistry (IIIrd Edition), G.Y. Miessler and D.A. Tarr.
7. Advanced Inorganic Chemistry - Vol. I - Satyaprakash, Tuli, Basu and Madan.
8. Selected Topics in Inorganic Chemistry - W.U. Malik, G.D. Tuli & R.D. Madan.
9. Chemistry of the Elements - N. N. Greenwood and A. Earnshaw.
10. Inorganic Chemistry,Atkins and Shriver.
11. Advanced Inorganic Chemistry Vol. I & Vol. II - Gurdeep and Raj.
12. Some aspect of Crystal Field theory- T. M. Dunn, D.S.Mcclure & R. G. Person

Paper: Supramolecular and Photo-inorganic chemistry (CH-IC 304)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 304	Supramolecular and Photo-inorganic chemistry	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of Supramolecular chemistry. To understand various mode of binding in supramolecules.

Learning Outcome:

- Students can understand fundamental concepts of Supramolecular Chemistry.
- They can understand the hidden facts for the interaction/binding in supramolecules.
- They can understand the fundamental and basic concepts of Photochemistry.
- They can understand physical and photochemical process for the excitation of the molecules.

Unit	Topics of Paper CH-IC 304	Marks	Teaching Hrs
	Section A		
1	**Supramolecular chemistry I** Introduction, nature of supramolecular interactions, cation binding hosts, crown ethers, lariat ethers, podands, cryptands, spherands, macrocyclic and template effects, calixarenes, siderophores, binding of anions- two dimensional and cyclophane hosts, guanidinium based, organometallic and neutral receptors, anticrowns, hydride sponge and other Lewis acid chelates, binding of neutral molecules, solid states clathrates, fullerene as guest, host and superconducting intercalation compounds.	15	15
2	**Supramolecular chemistry II** Templates and self-assembly- tennis balls and soft balls, catenanes and rotaxanes, helicates, molecular knots, supramolecular photochemistry, semiochemistry, molecular electronic devices-swithes, wires and rectifiers, dendrimers	15	15
	Section B		
3	**Basic concept of Photo Chemistry** Introduction to photochemistry, laws of photochemistry, Quantum yield, deviation in quantum yield, Experimental determination of quantum yield, Quantum yield and reactivity, life time of electronically excited state, kinetic aspects of photochemical reactions. **Inorganic photochemistry** Ligand field excited state, charge transfer excited state, ligand to metal, metal to ligand, charge transfer to solvent, tenteraligand stage, metal to metal stage. **Photochemical reactions** Photosubstitution, reaction, photo - rearrangement	15	15

	reaction, redoxreactions, promt and delayed photochemical reactions,d-d- and charge transfer reactions.		
4	**Photochemical reactions of coordination compounds** Chromium (III) complex, cobalt (III) complexes, radium (III) complex, complexes of transition elements, complexes of lanthanides and actinides. **Applications of photochemical reactions of coordination compounds** Synthesis, catalyst, chemical actinometry, photochromism and photocalorimetry.	15	15
	Objective questions from all units	10	

Reference books:

1. Supramolecular Chemistry by Jonathan Steed & Jerry Atwood will be the primarytextbook.
2. Supramolecular Chemistry: Concepts and Perspectives By Jean-Marie Lehn
3. Core Concepts in Supramolecular Chemistry and Nanochemistry By Jonathan W.Steed, David R. Turner, Karl Wallace.
4. Bioinorganic chemistry -Bertini Ivano, Gray H. B., Lippard S. J. & Valentine J. S.
5. Principles of Bioinorganic chemistry - S. J Lippard & M. J. Berg
6. Inorganic Biochemistry, (Vol.I & II) - G. L. Eicchorn.
7. Bioinorganic chemistry :- A. K. Das.

KADI SARVA VISHWAVIDYALYA
M.Sc In-Organic Chemistry Syllabus

Paper: Research Methodology-I (CC-301A)

Rationale of the Paper: To provide the basic knowledge of Research & Methodology

Learning Outcome:

- Students can learn the basic Introduction of Objective of research.
- Student will learn to define a research problem.

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CC-301A	**Research Methodology-I**	2	2	……..	50	------	50

Unit	Topics of PaperCC-301A	Marks	Teaching Hrs
1	**Research Methodology**: An Introduction Meaning of research, Objectives of research, motivation in research, Types of research, Research Approaches, significance of research, research method vs methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research, problems encounter by researchers in India.	25	15
2	**Defining Research Problem:** what is research problem? selecting the problem, necessity of defining the problem, Technique involved in defining a problem, an illustration, conclusion Research Design: Meaning of research design, need for research design, features of good design, important concepts relating to research design, different research designs, basic principles of experimental design	25	15

Reference Books:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, VivaBooks Pvt.Ltd., New Delhi
4. Writing Your Thesis by Paul Oliver, VistaarPublication, New Delhi, 2006 The Research Student's Guide to Success by Pat Cryer, Viva Books Pvt Ltd., New Delhi

Laboratory Course Sem-IIIInorganic Chemistry (CH-IC 305)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total
CH-IC 305	Inorganic chemistry Practical I	8	--	16	200	-----	200

Practical (minimum 15)

1. Gravimetry estimation of three metal ions from following:
   Ag^{+}, Cu^{++}, Ni^{++}, Zn^{++}, Fe^{+++}, Al^{+++}, Ba^{++} and Mg^{++}

2. EDTA Titration:
   Estimation of Mg^{++}, Zn^{++}, and Mg^{++} and Ca^{++} in admixture.

3. Separation of cations and anions by paper chromatography/column chromatography/ ion exchange.

4. Preparation and Characterization of some metal complexes.

KADI SARVA VISHWAVIDYALYA
M.Sc In-Organic Chemistry Syllabus

Semester IV

Paper: Modern trends in Bio-inorganic chemistry(CH-IC 401)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 401	**Modern trends in Bio-inorganic chemistry**	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of Photo and Bio-inorganic Chemistry. To understand various mode of excitation of molecules and biological importance of the Metals.

Learning Outcome:

Students can understand different concepts of rotational and vibrational spectroscopy

- They can also learn the interaction of metals with nucleic acids.
- Students can gain knowledge of storage of metals and their transportation through membranes.
- They could study the interaction of Metal ions with metal complexes and Nucleic acids.
- They can also learn the biomineralization and metal storage mechanism.

Unit	Topics of Paper CH-IC 401	Marks	Teaching Hrs
	Section A		
1	**Metal Nucleic Acid Interactions** Introduction, nucleic acid structures, structures and binding sites in nitrogen bases, phosphates and sugar base. Coordination complexes of nucleic acids and their bases with metal ions. Hydrogen bonding, redox reaction and hydrolytic reaction of nucleic acids mechanisms of these reactions, natures role, pharmaceutical role, catalytic role	15	15
2	**Storage of metals and transport across the membrane** The fluid mosaic model of membrane, types of transport and their mechanism, Transport and storage of alkali and alkaline earth metals, Na –K pump, calcium pump. Gibbs-Donnan equilibrium, Iron transport proteins and compounds.	15	15

	Section B		
3	**Interactions of metal ions and metal complexes** Structure and functions of amino acids, proteins, peptides, enzymes nucleoside, nucleotide andcomparative study of structures and functions of these biomolecules. Metal ion binding sites present in amino acids, peptides, proteins,enzymes, nucleoside and nucleotide. Interactions ofmetal ion and metal complexes with these biomolecules.	15	15
4	**Metal Storage Transport and Biomineralization** Ferritin, transferrin, and siderophores **Metals in Medicine** Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs	15	15
	Objective questions from all units	10	

Reference books:

1. Concepts of Inorganic Photo chemistry, W. Adamson
2. Photochemistry of Coordination Compound – V. Balzani and Carassiti, Acdemic pressLondon & New York
3. Inorganic spectroscopy, A. B. P. Lever
4. Inorganic Chemistry, J. E. Huhey
5. Fundamental of Photochemistry, Rohatgi Mukherjee
6. Charge Transfer Excitation of Coordination compounds. Generation of reactiveintermediate – A Vogler and H Kunkely
7. Inorganic biochemistry – Guther L. Eicchornvol 1&2 (Elsevier Scientific PublishingCompany Amsterdam 1973, London New York.
8. Parikh's Textbook of Medical Jurisprudence, Forensic Medicine and Toxicology (SixEdi8tion) By C. K. Prikh. (CBS Publishers & distributors 4596/1A 11, Daryagaing NewDelhi- 11002
9. Principles of bioinorganic chemistry – S. J Lippard & J M Berg , Mill Valley California
10. Elements of BVioinorganic - G N Mukherjii, and Arbinda Das U N Dhur and Sons Pvt.Ltd Kolkatta

Paper: Nano materials and Instrumental analysis (CHIC-402)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-IC 402	Nano materials and Instrumental analysis	4	4	--------	70	30	100

Rationale of the Paper: To provide the basic and advanced knowledge of Nanomaterials and Instrumental analysis. To understand various surface activity and thermal stabilityof nanomaterials the SEM, TEM and thermal instrumentation will help them.

Learning Outcome:

- Students can understand different Physical and Chemical methods of the synthesis of nanomaterials.
- They can understand the fundamental of surface activity of these materials with the concepts of SEM, TEM and XRD.
- They can understand the importance of thermal stability of these materials.

Unit	Topics of Paper CH-IC 402	Marks	Teaching Hrs
	Section A		
1	**General introduction & synthesis of nanomaterials by physical methods** Objective of study, synthesis of nanoparticles by physical method, mechanical methods- high energy ball milling, melt mixing, method based on evaporation, physical vapour deposition withconsolidation. Ionized cluster beam deposition. Laser vaporization, Laser pyrolysis, sputter deposition, electric arc deposition, Chemical Vapour Deposition (CVD).	15	15
2	**Synthesis of Nanomaterials by Chemical Methods** Introduction, colloids and colloids in solution, interaction of colloids and medium, colloids in vacuum, colloids in medium, effect of charge on colloids, stearic repulsion, synthesis of colloids, growth of nanoparticles, synthesis of metal and semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) method, sol gel method, electrochemical method.	15	15
	Section B		
3	**Surface Morphology** **XRD:** Symmetry elements in crystals, miller indices for planes and directions, criteria for determining unit cell of lattice, space lattices. Introduction, origin of X-rays, monochromatization and diffraction methods. Crystal structure elucidation limited to cubic system. Characteristic difference between X-ray, electron and neutron diffraction techniques Applications of XRD. **SEM and TEM:** Introduction, principle, theory, instrumentation and	15	15

	applications		
4	**Thermal Analysis** **TGA:** Introduction to thermal analysis, TG and DTG, static, Instrumentation, thermogram, factors affecting thermograms, application of thermogravimetry. Reaction Kinetics–kinetics by single and multiple heating rates. Differential thermal analysis, DTA theories, DTA curves, factors affecting DTA curves, Instrumentation, applications of DTA, simultaneous determination in thermal analysis. **DSC:** Introduction, Instrumentation, Power compensated DSC, Heat Flux DSC, DSC-curves, factors affecting DSC curves, applications	15	15
	Objective questions from all units	10	

Reference books:

1. Solid State Chemistry and applications- A.R. West (John Wiley and Sons)
2. Principles of the Solid State- H.V. Keer (Wiley Eastern Limited) 39
3. Nanotechnology: Principles and practices- Sulabha K. Kulkarni (capital Pub. Co.)
4. NANO- The next revolution –Mohan Surendra Rajan(National book Trust, India)
5. The British Glass Website- Types of Glass://www.britiglass.org.uk.
6. Fundamental of Nanotechnology – Gabor L. Hornyak, John J. Moore, Harry F. Tibbals, Joydeep Dutta.
7. Recent advances in the liquid phase synthesis of Inorganic Nanoparticles- B. L. CushingV. L. Kolesmichenko & C.J.O".Connor Chemical Review 104, 3893-3946.(2004).

Paper: Research Methodology-II (CC- 401A) Credit 02

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CC-401A	Research Methodology-II	2	2	……..	50	------	50

Rationale of the Paper: To provide the basic knowledge of Research & Methodology

Learning Outcome:

- Students can learn the methods to collect research data through different methods. Also understand role of computer in research
- Student will gain the knowledge of processing data and understand the guidelines of thesis writing.

Unit	Topics of PaperCC- 401A	Marks	Teaching Hrs
1	**Methods of Data Collection:** collection of primary data, observation method, Interview method, collection of data through questionnaires, collection of data through schedules, difference between questionnaires and schedules, some other method of data collection, collection of secondary data, selection of appropriate method for data collection, role of computer in research.	25	15
2	**Processing And analysing data:** Processing operations, solving problems in processing, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationship, simple regression analysis, multiple correlation and regression, partial correlation, association in case of attributes, significance of writing thesis, different types of research writing, guidelines of writing good thesis.	25	15

Reference Books:

1. Research Methodology: Methods & Techniques by C R Kothari, 2e, Wishwa Publication, New Delhi
2. Research Methodology by D K Bhattacharyya, 1 e, Excel Books, New Delhi, 2003
3. How to Research by Loraine Blaxter, Christina Hughes and Molcolm Tight, Viva Books Pvt.Ltd., New Delhi
4. Writing Your Thesis by Paul Oliver, VistaarPublication, New Delhi, 2006
5. The Research Student's Guide to Success by Pat Cryer, Viva Books Pvt Ltd., New Delhi

Laboratory Course Sem-IV Inorganic Chemistry (CH-IC-403)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total
CH-IC 403	Inorganic Chemistry Practical II	4	--	8	100	-----	100

Practical's (minimum 6)

1. Potentiometry:
a. Acid-Base, Redox Titrations.
b. Determination of stability constants of suitable complex systems.

2. Conductometry
Acid-Base and precipitation Titrations

3. Colorimetry and Spectrophotometry:
Estimation of the following metals in solution V, Cr, Mo, Fe and Ni.

4. Flame Photometry:
a. Estimation of sodium and potassium in admixture.
b. Estimation of magnesium and calcium in tap water.
c. Estimation of calcium in calcium salt solution.

Inorganic Chemistry- Dissertation /industrial training (CH-IC 404)

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total Marks
CH-IC 404	**Dissertation /industrial training**	12	------	12	250	50	300