

SHRI GOVIND GURU UNIVERSITY, GODHRA

B.Sc. CHEMISTRY – SEMESTER – V

MAJOR COURSE – 1 (THEROY)

Ancient Indian Perspectives on Inorganic Chemistry : BS23MJ5CH1

TOTAL CREDIT : 04

04 LECTURSE/WEEK

UNIT	TOPICS	CREDIT	HOURSE
UNIT -1	Sulabsutra and Vedic mathematics Concept of symmetry and geometrical patterns of Yantra, Mandala; geometrical precision in Yogasanas. Molecular symmetry Introduction, symmetry operations and symmetry elements: C_n, σ, S_n, i and E. Point groups for the molecules (excluding S_{2n} and I_h). Boron hydrides Preparation, properties and structure of diborane. Types of bonds found in higher boranes. Structure of B_4H_{10}, B_5H_9, B_5H_{11}, and $B_{10}H_{14}$.	01	15
UNIT -2	Vasheshika school of philosophy Kanad's concepts regarding atoms; Atma-Brahma in context of Bhagvad Geeta, Vedanta and their corelation to quantum world; Bhagvad Geeta as a source of inspiration for Robert Oppenheimer, Erwin Schrodinger and many other scientists. Quantum chemistry Setting up of operators for different observables, Hermitian operator, important theorems concerning Hermitian operator, Particle in a three dimensional box, The rigid Rotator, The Schrodinger equation in spherical polar coordinates for hydrogen atom, separation of variables, solution of R, θ and ϕ equations. Chemical bonding The Huckel Molecular Orbital (HMO) theory, variation principle, solution of Secular equation. Hybridization: Hybridization wave functions of sp, sp^2 and sp^3.	01	15
UNIT -3	Rasshastra-preparation of mineral/metallic drugs; Ancient dying techniques-natural dyes and mordants, Various Bhasmas (plant extracts with metals/minerals) and their application; Rasarnav- conversation between Shiv-Parvati regarding metals and their derivatives. Co-ordination Chemistry Reaction, kinetics and mechanism. Trans effect and trans influence, Applications of trans effect in synthesis and analysis. Theories of trans effect: Polarisation theory, π-bonding theory, MO theory. Lability, inertness, stability and instability. Kinetics and reaction rates of substitution Ligand field effect and reaction rates, mechanism of substitution reaction. Nucleophilic substitution reaction (SN_1 and SN_2) in octahedral complexes. Substitution in octahedral Co (III) complexes. Acid hydrolysis, base hydrolysis. Cis effect. Electron transfer reaction. Mechanism of redox reaction (inner-sphere and outer-sphere).	01	15
UNIT -4	Metallurgical Heritage of India Arthaśāstra as the earliest text describing gold, silver, and other metals; Processing of gold, silver, copper, iron, tin, mercury, and lead as mentioned in the Indian texts in the ancient and Medieval Period, Zinc distillation as mentioned in Rasārṇava, Rasratna and Rasaratnasamukāyā. Organomettallic Compounds Definition and classification of organomettallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.	01	15

	References: (1) Concise Inorganic Chemistry: J.D. Lee; Wiley India, 5th Edition (1996). (2) Shriver and Atkins Inorganic Chemistry: Atkins, Overton, Rourke, Weller, Armstrong; Oxford University Press, 5th Edition (2011). (3) Advanced Inorganic Chemistry: F.A. Cotton and Wilkinson G.; John Wiley, 5th Edition (1988). (4) Introductory Quantum Chemistry: A.K. Chandra; Tata- McGraw Hill, 4th Edition (1994). (5) Quantum chemistry: R.K. Prasad; New Age International, 4th Edition (2010). (6) Universal Consciousness: The bridge between Science and Spirituality; Karpouzos A. Think Lab. (2016) (7) Inorganic chemistry: James E. Huheey, 4th Edition, Wesley Publishing Company. (8) Mechanism of Inorganic reaction: Basalo and Pearson, 2nd Edition, Wiley Eastern Pvt Ltd. (9) History of Science, Philosophy and Culture in Indian Civilization: Science and Technology in India, Vol. XV, Part 1, Edited by A. Rahman. (10) "Minerals and Metals in Pre-Modern India" by Arun Kumar Biswas, Publisher: D.K. Printworld Pvt. Ltd., Year: 2001 (11) Advanced Inorganic chemistry: (Vol. 1) Satya Prakash, Tuli, Basu and Madan; S. Chand		
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SHRI GOVIND GURU UNIVERSITY, GODHRA

B.Sc. CHEMISTRY – SEMESTER – V

MAJOR COURSE – 2 (THEROY)

Analytical Chemistry : BS23MJ5CH2

TOTAL CREDIT – 04

LECTURSE/WEEK

UNIT	TOPICS	CREDIT	HOURSE
UNIT -1	(A) Visible Spectroscopy Introduction, Beer Lambert's law, instrumentation (light source, optical system, wavelength selector, light sensitive device), Accuracy and error of Spectrophotometry (B) Ultraviolet Spectroscopy Origin of UV Spectra, Principle, Electronic transition ($\sigma\text{-}\sigma^*$, $n\text{-}\sigma^*$, $\pi\text{-}\pi^*$ and $n\text{-}\pi^*$), relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect, red shift (bathochromic shift), blue shift (hypsochromic shift), hyperchromic effect, hypochromic effect (typical examples). Problems of Dienes and enones using Woodward-Fieserrules. Problems of aromatic ketones, aldehydes and esters using empirical rules.	01	15
UNIT -2	Infrared Spectroscopy Introduction, principle of IR spectroscopy, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups. Factors affecting frequencies, applications. Application of Hooke's law, characteristic stretching frequencies of O-H, N-H, C H, C-D, C=C, C=N, C=O functions; factors affecting stretching frequencies (H-bonding, mass effect, electronic factors, bond multiplicity, ring size). Structural Problems based on Only IR Spectroscopy.	01	15
UNIT -3	(A) Chromatographic methods General principle, classification of chromatographic separation. Ion exchange chromatography (Ion Exchange equilibria, Types of Ion Exchange capacity, Application of Ion Exchange resins). Gas Chromatography, Instrumentation and evolution of data. High Performance Liquid Chromatography (HPLC) Principle and Instrumentation. (B) Polarography Introduction, Principle, electrode, Types of currents, Determination of half wave potential, Ilkovic equation, methods of determining concentration (Standard addition method and Calibration method.	01	15
UNIT -4	(A) Atomic Spectroscopy Introduction, Principle, Flame Emission Spectroscopy (FES) and Atomic adsorption Spectroscopy (AAS), Principal, comparison and applications, Burners (Total consumption burner and Premix burners) (B) Raman Spectroscopy Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	01	15
	References (1) Introduction to Spectroscopy: Donald L. Pavia, Gary M. Lampman, George S. Kriz Cengage Learning; 4th Edition. (2) Spectrometric Identification of Organic Compounds: Robert M. Silverstein, Francis X. Webster, David Kiemle Wiley; 7th Edition. (3) Applications of spectroscopic techniques in Organic Chemistry: P.S. Kalsi, New Age International; 6th Edition. (4) Elementary Organic Spectroscopy; Principles And Chemical Applications: Y. R. Sharma, S. Chand & Co Pvt Ltd. (5) Modern Raman Spectroscopy: A Practical Approach; Ewen Smith, Geoffrey Dent., Wiley; 1st Edition. (6) Analytical Chemistry: Gary D. Christian, 6th Edition; Wiley & Sons		

	(7) Fundamentals of Analytical Chemistry: D. A. Skoog, D. M. West and F. J. Holler, 9th Edition, Cengage Learning. (8) Instrumental Methods of analysis: (CBS) H.H . Willard, L.L. Mirrit, J.A. Dean		
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SHRI GOVIND GURU UNIVERSITY, GODHRA
B.Sc. CHEMISTRY – SEMESTER – V
MAJOR COURSE (PRACTICAL)
BS23MJ5CH3

TOTAL CREDIT – 04

Learning Objectives: To introduce fundamentals of organic separation and identification of organic compounds. To familiarize students with the concept of kinetics, conductometric titrations, colorimeter, PH meter, Potentiometer through practical methods.

Learning outcomes: After completion of course the students will be able to explain and perform organic separation and identification. The students will be able to perform experiment regarding colorimeter, PH meter, Potentiometer conductometric titrations.

[A] Organic: Organic separation and Identification: Separation of Binary Mixtures and Identification (Minimum 8 Mixtures)

(i) Solid + Solid (5 Mixtures)

(ii) Liquid + Liquid (3 Mixtures)

One Mixture from each of the following should be given Acid-Base, Acid-Phenol, Acid-Neutral, Phenol-Base, Phenol-Neutral, Base-Neutral, and Neutral-Neutral. Water soluble compounds are included. Identification of separated organic compound must be done by physical and chemical tests, sodium fusion test, M.P / B.P., derivatives and crystallization.

[B] Physical: (Kinetics and Instruments)

(1) Kinetics: Investigate the order of reaction in the following experiments by graphical method.

Exp 1: Reaction between KBrO_3 and KI ($a \neq b$)

Exp 2: Reaction between H_2O_2 and HI ($a = b$)

(2) Instruments:

Exp 1: Titration of unknown strength of HCl with standard NaOH solution using pH meter.

Exp 2: Titration of unknown strength of HCl with standard NaOH solution using Potentiometer.

Exp 3: Determine the amount of bases in given mix ($\text{NaOH} + \text{NH}_4\text{OH}$) Conductometrically using standard solution of HCl

Exp 4: To determine the concentration of CrO_4^{2-} and Ni^{2+} in solution by colourimetry.

Reference Books

(1) A. I. Vogel, "Elementary Practical Organic Chemistry Part-II, Qualitative Organic Analysis": CBS Publishers & Distributors, New Delhi, 2nd Edition, 2004.

(2) A. I. Vogel, "Elementary Practical Organic Chemistry Part III Quantitative Organic Analysis": CBS Publishers & Distributors, New Delhi, 2nd Edition, 2004.

(3) Hand book of Organic qualitative analysis by H. T. Clarke.

(4) Practical Organic Chemistry: F. G. Mann and B. C. Saunders. Low – priced Text Book. ELBS, Longman.

(5) V.K. Ahluwalia, Sunita Dhingra, "Comprehensive Practical Organic Chemistry –Qualitative Analysis": University Press (India) Private Limited, Hyderabad, 1st Indian Edition, 2010.

(6) "Advanced Practical Organic Chemistry": Stanley Thornes Publishers Ltd., J Leonard, B Lygo, G Procter, 1st Indian Edition, 2004.

(7) J. B. Yadav, "Advanced Practical Physical Chemistry": Krishna Prakashan, Meerut, 29th Edition, 2010.

(8) P. H. Parsania, "Experiments in Physical Chemistry": Neminath Printers Rajkot 1st Edition 2004.

(9) A. M. James and F. E. Prichard, "Practical Physical Chemistry": Longman Group Limited London 3rd Edition Reprinted 1979

SHRI GOVIND GURU UNIVERSITY, GODHRA

B.Sc. CHEMISTRY – SEMESTER – V

MINOR COURSE – 1 (THEROY)

Nanoscale Materials and their Applications : BS23MN5CH1

TOTAL CREDIT - 04

LECTURSE/WEEK

UNIT	TOPICS	CREDIT	HOURSE
UNIT -1	Introduction to nanodimensions 0D, 1D, 2D nanomaterials, Quantum Dots, Nanoparticles, Nanostructures (nanowires, thin films, nanorods), carbon nanostructures (carbon nanotubes, carbon nanofibers, fullerenes), Size Effects in nano systems, Quantum confinement and its consequences, Semiconductors. Band structure and band gap. Preparation of nanomaterials Top down and Bottomup approach, Photolithography. Ball milling. Vacuum deposition. Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Thermal decomposition, Chemical reduction, Sol-Gel synthesis, Hydrothermal synthesis, Spray pyrolysis, Electrochemical deposition, Pulsed Laser deposition.	01	15
UNIT -2	Characterization techniques (Basic working principles and interpretation of experimental data using these techniques need to be covered) UV-visible spectroscopy, X-ray diffraction (Powder and Single Crystal), Raman Spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Dynamic light scattering (DLS), Brunauer-Emmett-Teller (BET) Surface area measurement and Thermogravimetric analysis (TG).	01	15
UNIT -3	Optical Properties Surface plasmon resonance, Excitons in direct and indirect band gap semiconductor nanocrystals. Radiative processes: General absorption, emission and luminescence (fluorescence and photoluminescence). Conducting properties Carrier transport in nanostructures. Tunneling and hopping conductivity. Defects and impurities: Deep level and surface defects.	01	15
UNIT -4	Applications Nanomaterials as Catalysts, semiconductor nanomaterials as photocatalysts, Nanocomposites as catalysts. Carbon nanostructures as catalytic nanoreactors, metal and metal oxides confined inside carbon nanostructures, Nanowires and thin films for photonic devices (LEDs, solar cells, transistors).	01	15
	References 1. West, A. R. (2014), Solid State Chemistry and Its Application, Wiley 2. Smart, L. E.; Moore, E. A. (2012), Solid State Chemistry An Introduction, CRC Press Taylor & Francis. 3. Rao, C. N. R.; Gopalakrishnan, J. (1997), New Direction in Solid State Chemistry, Cambridge University Press. 4. Poole, Jr.; Charles P.; Owens, Frank J.; (2003), Introduction to Nanotechnology, John Wiley and Sons. 5. Chattopadhyay, K.K.; Banerjee, A. N. (2009), Introduction to Nanoscience and Technology, PHI.		

SHRI GOVIND GURU UNIVERSITY, GODHRA
B.Sc. CHEMISTRY – SEMESTER – VI
MAJOR COURSE – 1 (THEROY)
BS23MJ6CH1

Contributions of Indians to Organic Chemistry

TOTAL CREDIT - 04

LECTURSE/WEEK

UNIT	TOPICS	CREDIT	HOURSE
UNIT -1	Stereo Chemistry Optical activity in the absence of chiral carbon (Biphenyls, Allenes and Spirans); Concept of prostereo isomerism and chiral synthesis (Asymmetric Induction), Cram's rule, Prelog's generalization, Prelog's rule and assignment of configuration. Stereoselectivity and Stereospecificity: Stereoselective and stereospecific reactions. Mechanism "Addition of halogens to alkenes". Stereochemistry of E2 reaction (syn and anti-elimination).	01	15
UNIT -2	Name Reactions and reagents developed by Indian Chemists Mechanism and Synthetic applications of the reactions: Baker-Venkatraman rearrangement, Bardhan-Sengupta synthesis, Narasaka-Prasad Reduction, Ramachary reductive coupling, Wolf rearrangement and Fries migration. Use of specific reagents and their synthetic applications with mechanism. Aluminum Iso propoxide, Lithium Aluminum Hydride, Selenium Dioxide, Osmium Tetroxide, Lead Tetra acetate, Corey-Bakshi-Shibata catalyst and Singh's Catalyst	01	15
UNIT -3	(A) Nucleophilic Substitution at a Saturated Carbon Atom Mechanism and scope of reaction-available mechanism, Kinetic Characteristics, Scope of reaction, Stereochemistry of SN1 and SN2 reactions, Relative reactivity in substitution, Solvent effect, variation at carbon site, Relative leaving group activity, SNi (substitution nucleophilic internal) Mechanism and Neighbouring group participation. Elimination Reactions, E1, E2 and E1cB mechanism, Orientation E1 and E2 reactions, Elimination Vs Substitution.	01	15
UNIT -4	Natural Products (A) Plant-based Medicines and Alkaloids in Ayurveda Alkaloid content of Indian medicinal plants like Ashwagandha, Tulsi, and Neem. Ethanol production and traditional knowledge of anaerobic processes. Classification, General method of determining structure, analytical and synthetic methods, structure of Coniine, Nicotine, Atropine. (B) Isoprenoids; Natural Dyes and Pigments from Indian Sources Classification, General method of determining structure, Isoprene rule, Chemistry of Citral, α -Terpineol, Camphor and their synthesis. Synthesis and structure of natural colorants (e.g., indigo, turmeric, madder). Extraction and chemical modification of plant-based dyes used in traditional textiles.	01	15
	References: (1) Organic Chemistry: I. L. Finar, Vol-II, 5th Edition, Pearson Education Ltd. (2) Organic Chemistry: Morrison & Boyd, 6th Edition, Prentice Hall of India Pvt. Ltd. (3) Stereochemistry of carbon compounds: E. L. Eliel, Wiley Eastern Ltd. (4) Stereochemistry and mechanism through solved problems: P. S. Kalsi, New Age International. (5) Organic Chemistry: Hendrickson, Cram, Hammond, Mc Graw-Hill. (6) Organic Chemistry: Jonathan Clayden, Nick Greeves, Stuart Warren and Peter Wothers. Oxford University Press, USA. (7) Name Reactions and Catalysts Developed by Indian Chemists, Resonance, 2023, 28, 1373-1389.		

SHRI GOVIND GURU UNIVERSITY, GODHRA
B.Sc. CHEMISTRY – SEMESTER – VI
MAJOR COURSE – 1 (THEROY)
BS23MJ6CH2
Physical Chemistry

TOTAL CREDIT – 04

LECTURSE/WEEK

UNIT	TOPICS	CREDIT	HOURSE
UNIT -1	Phase Rule Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solidliquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications (H ₂ O and sulphur system). Phase diagrams for systems of solid-liquid equilibria involving eutectic (Pb-Ag system, desilverisation of lead), congruent (ferric chloride water) and incongruent (sodium sulphate-water) melting points, completely miscible solid solutions (intermediate, medium, maximum freezing points).	01	15
UNIT -2	(A) Molecular Spectroscopy Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity. (B) NMR Spectroscopy Principle, Magnetic and non magnetic nuclei, absorption of radio frequency. Equivalent and non equivalent protons, chemical shifts, anisotropic effect, relative strength of signals, spin-spin coupling, Deuterium labelling, applications to simple structural problem	01	15
UNIT -3	Photochemistry Characteristics of electromagnetic radiation, physical significance of absorption coefficients. Laws of photochemistry; Grothuss-Drapper law, Lambert's law, Lambert-Beer's law, Stark Einstein law, Jablonski diagram depicting various processes occurring in the excited state, fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching, chemiluminescence.	01	15
UNIT -4	Electrochemistry Electrochemical cell, Liquid junction potential and its determination, Debye-Huckel limiting law and its verification. Debye Huckel – Onsagar equation-verification and limitations, Bjerrum treatment of electrolytes. Inert electrodes-Membrane electrodes, theory of glass membrane potential. Electrode potentials; Double layer at the interface, rate of charge transfer, Decomposition potential, Over potential, Tafel plots, Derivation of Butler- Volmer equation for one electron transfer, electro chemical potential.	01	15
	References: (1) Physical Chemistry: G. M. Barrow, 5th Edition, McGraw-Hill education, India. (2) Advanced Physical Chemistry: Gurdeep Raj, 35th Edition (2009), Goel / Krshina Publishing House. (3) Principles of Physical Chemistry: Puri, Sharma and Pathania, 42nd Edition, Vishal Publishing Company. (4) Physical Chemistry: Atkins, 9th Edition. Oxford University Press. (5) Advanced Physical chemistry: Gurtu and Gurtu, 11th Edition ,Pragati Prakashan. (6) Spectroscopic Method in Organic Chemistry: Dudley Williams, Ian Fleming McGraw-Hill		

	Education; 6th Edition. (7) Applications of spectroscopic techniques in Organic Chemistry: P.S. Kalsi, New Age International; 6th Edition. (8) Fundamentals of Molecular Spectroscopy: C. M. Banwell and E. McCash, Tata McGraw Hill, 4th Edition.		
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SHRI GOVIND GURU UNIVERSITY, GODHRA**B.Sc. CHEMISTRY – SEMESTER – VI****MAJOR COURSE – 1 (THEORY)****BS23MN6CH1****Industrial Chemistry in Daily Life (Theory)****TOTAL CREDIT - 02****LECTURE/WEEK**

UNIT	TOPICS	CREDIT	HOURS
UNIT -1	Chemistry of Cosmetics A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotion, face powder, lipsticks, talcum powder, nail enamel, cold creams, vanishing creams, shaving creams. Qualitative and quantitative analysis of borates, carbonates, sulphates, phosphate, titanium and zinc oxide. Analysis of face powder, deodorants and antiperspirants.	01	15
UNIT -2	Food Analysis Introduction, Reasons for analyzing food, Food safety. Adulteration and contamination: definition. Analysis of moisture of vegetable oils, butter and ghee, honey. Analysis of ash content in spices, honey. Analysis of fat in butter. Analysis of protein content in milk, butter. Analysis of reducing sugar of honey. Standard content of some food material.	01	15
	References: (1) E. Stocchi: Industrial chemistry, Vol-I, Ellis Horwood Ltd. UK. (2) P.C. Jain, M. Jain : Engineering Chemistry, Dhanpat Rai & Sons, Delhi. (3) Sharma, B. K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996). (4) Basic Text & Reference Books:- Analytical Chemistry by Dr. Alka Gupta, Pragati Prakashan. (5) Instrumental Methods of Chemical Analysis by Chatwal and Anand (6) Cosmetics by W. D. Poucher (three volumes)		

SHRI GOVIND GURU UNIVERSITY, GODHRA
B.Sc. CHEMISTRY – SEMESTER – VI
MAJOR COURSE (PRACTICAL)
BS23MJ6CH3

TOTAL CREDIT – 04

[A] Inorganic Quantitative Analysis:

(I) Gravimetric determination of the radicals: (After removal of interfering radicals in mixed solution)

(a) BaCl_2 , FeCl_3 and HCl (Determination of Ba as BaSO_4)

(b) CuSO_4 , $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4$ and H_2SO_4 (Determination of Fe as Fe_2O_3)

(c) CuSO_4 , $\text{Al}_2(\text{SO}_4)_3$ and H_2SO_4 (Determination of Al as Al_2O_3)

(II) Analysis of Alloy:

Brass (Cu $\rightarrow$ Volumetrically, Zn $\rightarrow$ Gravimetrically)

[B] Inorganic Qualitative Analysis: Inorganic Qualitative Analysis of mixture containing six radicals only.

(Minimum 08 mixtures to be done)

Reference Books

(1) Vogel's "Textbook of Quantitative Chemical Analysis": Pearson Education Ltd. 6th Edition, 2008.

(2) Vogel's "Qualitative Inorganic Analysis": Pearson Education Ltd. 7th Edition, 2009.

(3) Gurdeep Raj, "Advanced Practical Inorganic Chemistry": Krishna Prakashan, Meerut, 21st Edition, 2009.

(4) "Quantitative Analysis": R. A. Day, A. L. Underwood, Prentice-Hall of India Pvt. Ltd., New Delhi, 6th Edition, 2004