John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai-400007

RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Syllabus for PG Second Year (S.Y.)
under
New Education Policy (NEP 2020)

Program: M.Sc. (Inorganic Chemistry)

Program Code: WSCHI (Inorganic Chemistry)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAM OUTLINE 2024-2025

YEAR / UNIT	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc-II SEM III	**Mandatory Course -I**	WSCHIMT631	Bioinorganic and Coordination Chemistry.	**04**
	Mandatory Course -II	WSCHIMT632	Spectral Methods in Inorganic Chemistry	**04**
	Mandatory Course -III	WSCHIMP631	Inorganic Practical-I	**04**
	Mandatory Course -IV	WSCHIMT633	Chemistry of Inorganic Solids	**02**
	Elective theory	WSCHIET631 OR WSCHIET632	Applied Chemistry OR Inorganic Materials	**02**
	Elective practical	WSCHIEP631	Solvent Extraction / Analysis of samples-I	**02**
	Project	WSCHIRP631	Industrial training /Field Project	**04**
MSc-II SEM IV	**Mandatory Course -I**	WSCHIMT641	Organometallics and main group Chemistry	**04**
	Mandatory Course -II	WSCHIMT642	Instrumental methods in Inorganic Chemistry and Group theory	**04**
	Mandatory Course -III	WSCHIMP641	Inorganic Practical -II	**04**
	Elective Theory	WSCHIET641 OR WSCHIET642	Intellectual Property Right OR Properties of Inorganic Solids	**02**
	Elective Practical	WSCHIEP641	Analysis of samples-II	**02**
	Project	WSCHIRP641	Dissertation	**06**

PROGRAMME SPECIFIC OUTCOME (PSOs)

1. Gain knowledge of the advanced concepts in the branch of chemistry, scrutinize and accomplish a solution to problems encountered in the field of research and analysis.

2. Apply the basic knowledge of chemistry to perform various tasks assigned to them at the workplace in industry and academia to meet the global standards.

3. Deduce qualitative and quantitative information of chemical compounds using advanced spectroscopic methods which can further be analysed using practical skills inculcated in them during the course.

4. Imbibe the attitude as well as aptitude of a scientific approach along with analytical reasoning with respect to the novel techniques actually implemented in the Industry.

5. Use the subject knowledge, communication and ICT skills to become an effective team leader/team member in the interdisciplinary fields.

6. Understand, Manage and contribute to solve basic societal issues and environmental concerns ethically based on principles of scientific knowledge gained.

7. Exhibit professional work ethics and norms of scientific development.

PREAMBLE:

Master of Science of Science (M.Sc.) in Chemistry is an postgraduate course of Department of Chemistry, Wilson College, Chowpatty, Mumbai (Autonomous). The Choice Based Credit System to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities.

This syllabus is prepared to give the sound knowledge and understanding of chemistry to postgraduate students in the Second year of the M.Sc. degree course. The goal of the syllabus is to make the study of Chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying Chemistry in academic and industrial courses. Also, to expose the students and to develop interest in them in various fields of Chemistry.

The new and updated syllabus is based on a interdisciplinary approach with vigour and depth taking care that the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The students pursuing this course would have to develop an understanding of various aspects of chemistry. The conceptual understanding, development of experimental skills, developing the aptitude for academic and professional skills, obtaining basic ideas and understanding of hyphenated techniques, understanding the fundamental chemical processes and rationale towards application of knowledge are among such important aspects.

SEMESTER: III

PROGRAM(s): M.Sc.-II		**SEMESTER: III**			
Course Code:WSCHIMT631		**Course Title: Bioinorganic and Coordination Chemistry.**			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (marks)**	**Semester End Examination (marks)**
04	**NA**	**-**	**04**	**40**	**60**

Learning Objectives:

1. To comprehend the geometry and purposes of different coordination metal complexes in the biological system.
2. Acquire knowledge of the various techniques for calculating the stability constant of coordination compounds, which aids in comprehension of the reactive properties of the compounds.
3. To familiarise students with the Drago Wayland equations, Latimer, and Pourbaix diagrams which will enable them to comprehend the different redox reactions that occur in media that are aqueous, non-aqueous, and solvent free.

Course Outcomes: Students will able to

1. explore the geometry and function of various coordination metal complexes within biological systems, as well as the binding of metal ions to biomolecules and their respective roles.
2. comprehend the characteristics, classification, and reactivity of Lewis acids and bases.
3. analyze trends in the properties and applications of p-block and d-block elements.
4. study the structure, bonding, and stereochemistry of various coordination compounds.

Course Code:- WSCHIMT631**- Bioinorganic and Coordination Chemistry.**			
Paper-II	**Unit**	**Course/ Unit Title**	**04 Credits / (60 L)**
	I	**Bioinorganic and Coordination Chemistry.**	**15 L**
		1.1 Bioinorganic Chemistry 1.1.1 Coordination geometry of the metal ion and functions. 1.1.2 Zn in biological systems: Carbonic anhydrase, protolytic enzymes, e.g. carboxy peptidase, Zinc finger. 1.1.3 Role of metal ions in biological electron transfer processes: iron sulphur proteins, 1.1.4 Less common ions in biology e.g. Mn(arginase; structure and reactivity), Ni (urease ;structure and reactivity) 1.1.5 Biomineralization	

	II	**Magnetic properties of complexes**	**15L**
		1.2.1 Origin of magnetism, classification of substances according to the magnetic properties: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism. 1.2.2 Magnetic moment from magnetic susceptibility, Curie equation and Curie temperature, Curie-Weiss law, Neel temperature, thermal energy and magnetic moment: multiplet width greater than kT, multiplet width large than kT, temperature independent paramagnetism, magnetic susceptibility and spin only formula, spin and orbital contribution to magnetic moment, spin cross-over. 1.2.3 Magnetic properties of transition metal and lanthanide complexes, diamagnetic correction using Pascal constants and calculation of magnetic moment. Methods of determination of magnetic susceptibility.	
	III	**Reactivity of Chemical Species**	
		2.3.1 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. 2.3.2 Oxoanions and Oxocations, Pauling rules to determine the strength of oxoacids; classification and Structural anomalies. 2.3.3 Pourbaix Diagrams. Measures of hardness and Softness of Acids and Bases, Dragowayland equations, 2.3.4 Applications of acid-base Chemistry: Super acids and Super bases, heterogeneous acid-base reactions 2.2.5 Amphoteric behavior, Periodic trends in amphoteric properties of p-block and d-block elements	
	IV	**Structure, Bonding, and Stereochemistry of Coordination Compounds**	**15 L**
		1.4.1 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. 1.4.2 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.	

REFERENCES:

1. Gary Wulfsberg, Inorganic Chemistry; Viva Books PA Ltd., New Delhi; 2002.
2. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd edition.
3. James E.Huheey, Inorganic Chemistry, 3rd edition, Harper & Row,Publishers, Asia, Pte Ltd., 1983.

4. W.W.Porterfield,Inorganic Chemistry-An Unified Approach,Academic press(1993);
5. D.F.Shriver, P.W.Atkins and C.H. Langford, Inorganic Chemistry,3rd edition Oxford University Press, 1999.
6. Asim K.Das, Fundamental Concepts of Inorganic Chemistry,(Volumes-I,II and III)CBS Pub.(2000)
7. N.N.Greenwood and A.Earnshaw, Chemistry of Elements, Pergamon, 1984.
8. J.M.Hollas, Symmetry in Chemistry, Chapmanad Hall Ltd., NY, 1972.\
9. F.A.Cotton, Chemical Applications of Group Theory, 2nd edition, Wiley Eastern Ltd., New Delhi , 1976
10. C.J.Ballhausen and H.B.Gray, Molecular Orbital Theory, MCGraw-Hill, New York, 1965.
11. H. Sisler, Chemistry in Non-aqueous Solvents: New York Reinhold Publ. 1965.
12. J.J. Lagowski, The Chemistry of Non-aqueous Solvents, Academic press, New york and London.
13. C.M. Day and Joel Selbin, Theoretical Inorganic Chemistry,Affiliated East West Press Pvt.Ltd., 1985.
14. L.E.Orgel, An Introduction to Ligand Field Theory, Methuen & Co. Ltd., London, 1960.
15. F.Basolo and R.G.Pearson, Mechanisms of Inorganic Reactions, Wiley, New York, 1967.
16. J.D.Lee, Concise Inorganic Chemistry, 5th ed., Blackwell ScienceLtd., 2005.
17. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley-Interscience, New york, 1988.
18. G.W.Parshall and S.D.Ittel, Homogeneous Catalysis, 2nd edition,John Wiley & sons, Inc., New York, 1992.
20. R.C.Mehrotra and A.Singh, Organometallic Chemistry-A UnifiedApproach, 2nd ed., New Age International Pvt.Ltd., 2000.
21. B.Douglas, D.H. McDaniel and J.J.Alexander, Concepts and Models of Inorganic Chmistry, 2nd edition, John Wiley & Sons,1983.
22. James E.Huheey, Inoganic Chemistry-Principles of structure and reactivity, edn Harper & Row Publishers (1972).
23. F. A. Cotton, G. Wilkinson, C. Murillo and M. Bochmann,Advanced Inorganic Chemistry, 6th ed., John Wiley, New York,1999.
24. F.A. Cotton and R.A.Walton, Multiple Bonds between MetalAtoms, 2nd edition, claranden Press, Oxford, 1993.
25. P.L. Soni, Vandana Soni ,Ane Books Pvt.,Ltd
26. R. A. Dutta & A. Syamal, Elements of magnetochemistry, 2nd edition, Affiliated East-West Press Pvt. Ltd. (1993).
27. D. Banerjea, Coordination chemistry, 3rd edition, Asian Books Pvt. Ltd. (2009).

PROGRAM(s): M.Sc.-II		SEMESTER: III			
Course code : WSCHIMT632		**Course Title:** Spectral Methods in Inorganic Chemistry			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (marks)**	**Semester End Examination (marks)**
04	**NA**	**-**	**04**	**40**	**60**

Learning Objectives:
To explain structural methods based on various physical phenomena, such as X-ray, electron, and neutron wave, monochromatic radiation resonance, electron spin resonance (ESR), and Mossbauer spectroscopy.

Course Outcomes: students will able to

1. analyze various X-Ray diffraction methods of crystals.
2. investigate electron and neutron diffraction techniques of various compounds.
3. examine Electron Spin Resonance spectral methods of various metal complexes. analyze Mossbauer spectral techniques used for studying various compounds.

WPSCHIMT632**- Spectral Methods in Inorganic Chemistry**			
Paper-II	**Unit**	**Course/ Unit Title**	**04 Credits/ (60 L)**
	I	**Diffraction Methods –I**	**15 L**
		2.1.1 Introduction to X-ray diffraction, generation of X-rays (K-shell knockout), Bragg condition, Miller indices, relationship between Miller indices and inter planar spacing. 2.1.2 Methods of diffraction: Laue Method; 2.1.3 Debye Scherrer Method of X-Ray Structural Analysis of 2.1.4 Crystal introduction to JCPDS format, index reflections, identification of unit-cells from systematic absences in diffraction pattern, uses of powder X-ray diffraction, description of the procedure for an X-ray structure analysis, density and crystallite size determination (numerical problems are expected).	
	II	**Diffraction Methods –II**	**15 L**
		2.2.1 Electron Diffraction: Scattering of electrons, Scattering Intensity versus Scattering Angle, Weirl Measurement Technique, Elucidation of Structures of Simple gas Phase Molecules.	

		2.2.2 Neutron Diffraction: Scattering of Neutrons: Scattering of neutrons by Solids and Liquids, Magnetic Scattering, Measurement Technique	
	III	**Electron Spin Resonance Spectroscopy**	**15 L**
		2.3.1 Electron behaviour, interaction between electron spin and magnetic field. 2.3.2 Instrumentation : Source, Sample cavity. Magnet and Modulation coils, Microwave Bridge, Sensitivity. 2.3.3 Relaxation processes and Line width in ESR transitions: (i) ESR relaxation and chemical bonding. (ii) Interaction between nuclear spin and electron spin (hyperfine coupling) (iii) Spin polarization for atoms and transition metal ions, (iv) Spin-orbit coupling and significance of gtensors, (v) Application to transition metal complexes (having one unpaired electron)	
	IV	**Mössbauer Spectroscopy:**	**15 L**
		2.4.1 Basic principle, recoil energy and Doppler shift. 2.4.2 Instrumentation: sources and absorber; motion devices, detection, reference substances and calibration, 2.4.3 Isomer shift, quadrupole interaction, magnetic interaction, electronegativity and chemical shift. 2.4.4 Applications: Iron compounds- low spin and high spin Fe(II) and Fe(III) compounds and complexes, effect of pibonding, mono and polynuclear Iron complexes, spinel oxides and iron-sulphur proteins; Tin compounds- tin halides and tin oxides, organotin compounds; Iodine compounds- I_2 and alkali metal iodide compounds	

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1. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis Fifth edition, (1996),ELBS Publication. Chapter 2, 3, 11.

2. W.H. Zachariasen. Theory of X-Ray Diffration in Crystals. JohnWiley. New York. 1946.

3. B.D. Cality,, Elements of X-Ray Diffraction Procedures. John Wiley and Sons. New York, 1954.

4. R. Reaching, Electron Diffraction, Methuen and Co. London. 1936

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6. H.H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle, Instrumental Methods of Analysis, C.B.S. Publishers and Distributors, New Delhi, 1986.

7. P.J. Horne, Nuclear Magnetic Resonance. Oxford University Press, Oxford, 1995.

8. Reverts John D., Nuclear Magnetic Resonance, McGraw Hill, NewYork, 1959.

9. H. Kambe and P.D.Garn. Thermal Analysis, Kondansha Ltd. Toyo,1974.

10. G.W. Ewing, Instrumental Methods, Of Analysis, 4th Ed. McFraw Hill Ltd., 1970.

11. N.H. Ring, Inorganic Polymers, Academic Press, New York, 1978

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14. M.T.R. Series, The Superheavy Elements.
15. Haissilsky, Nuclear Chemistry and its Application, 1962.
16. S. Glasstone, Sourcebook of Aomic Energy, East-West Publisher,1969.
17. D.Harvey,Modern Analytical Chemistry, The McGraw-Hill Pub,1st Edition(2000);
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21. Graham Smith; David Keeble.Introduction to Modern EPR Spectroscopy CRC Press 2013.
22. C.N.R. Rao, Chemical Applications of Infrared Spectroscopy Academic Pess,N.Y.(1963
23. K. Veera Reddy, Symmetry and Spectroscopy,
24. Paul Gabbott Principles and Applications of Thermal Analysis Wiley-Blackwell ; edition (2007)
25. . Richard Vernon Parish, NMR, NQR, EPR, and Mössbauer spectroscopy in inorganic chemistry, Publisher,E,.Horwood,(1990)

PROGRAM(s): M.Sc.-II		SEMESTER: III			
Course Code :WSCHIMP631		Course Title : Inorganic Practical-I			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (marks)	Semester End Examination (marks)
NA	08	NA	04	40	60

Learning Objectives:

1. To dissolve the given alloy using a suitable acid treatment, then quantify the amount of metal present by using a gravimetric or volumetric technique.
2. To prepare various coordination compounds.

To analyse the commercial samples for the active ingredients.

Course Outcomes: students able to

1. conduct the analysis of an alloy and quantitatively estimate the metal content present in it using gravimetric or volumetric methods.
2. demonstrate the preparation of various coordination complexes.
3. execute quantitative analysis of some metals using the volumetric titration method.

	Course code: WSCHIMP631-Inorganic Practical -I	
	Analysis of alloys : **Estimation of alloy -Non-Instrumental:**	**04 Credits**
	Analysis of 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.	
	Synthesis of metal complexes	
	Inorganic Preparations 1. Preparation of V(oxinate)3 2. Preparation of Sn(IV) Iodide 3. Preparation of Co(α-nitroso-β-naphthol)3 4. Preparation of Ni(salicylaldoxime)2 5. Hexamine cobalt (III) chloride 6. Preparation of Trans-bis (glycinato) Cu(II)	

	Synthesis and characterization of Inorganic compounds.	
	1. Preparation of [$Mn(acac)_3$] and its characterization by IR and conductivity measurement. 2. Preparation of CuO/ZnO nanoparticles and its characterization by UV-Visible and XRD techniques. 3. Synthesis of tris(acetyl acetonato)aluminium (III) complex and its characterization by NMR. 4. Synthesis of bis(salicyl aldiminato)copper (II) complex and its characterization by ESR. 5. Synthesis of calcium oxalate and its characterization by TGA/DTA.	

Reference books for practical

1. A. I. Vogel, Quantitative Inorganic Analysis.
2. J. D. Woolins, Inorganic Experiments.
3. Palmer, Inorganic Preparations.
4. G. Raj, Advanced Practical Inorganic Chemistry.
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, (2013).

PROGRAM(s): M.Sc.-II		SEMESTER: III			
Course Code : WSCHIMT633		**Course Title :**Chemistry of Inorganic Solids			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (marks)**	**Semester End Examination (marks)**
02	**02**	**-**	**02**	**20**	**30**

Learning Objectives:

1. To aid the student's understanding of linked polyhedral units and the structures of basic compounds.
2. To study the various processes used to create crystal structures, as well as their reactions and properties.

Course Outcomes: students able to

1. analyze the structures of simple compounds and linked polyhedral units.
2. evaluate various defects in crystals to design and explore different inorganic compounds with desired properties.

Course Code: WSCHIMT633**- Chemistry of Inorganic Solids**		
Unit		**02 Credits / (30 L)**
I	**Descriptive Crystal Chemistry:**	**15 L**
	3.1.1 Simple structures of AB type compounds (PbO and CuO), (a)AB_2 type (β cristobalite, CaC_2 and Cs_2O), (b) A_2B_3 type (Cr_2O_3 and Bi_2O_3), (c) AB_3 (ReO_3, Li_3N), (d)ABO_3 type, relation between ReO_3 and perovskite $BaTiO_3$ and its polymorphmic forms, Oxide bronzes, ilmenite structure, (e) AB_2O_4 type, normal, inverse, and random spinel structures.	**8 L**

	3.1.2 Linked Polyhedra (i) Corner sharing: tetrahedral structure (Silicates) and octahedral structure(ReO_3) (ii) Edge sharing: tetrahedral structures (SiS2) and octahedral structures (BiI_3 and $AlCl_3$). pyrochlores, octahedral tunnel structures and lamellar structures.	**7 L**
II	**Imperfection in crystals and NonStoichiometry:**	**15 L**
	3.2.1 Point 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 centres.)	
	3.2.2 Line defects: Edge and Screw Dislocations. Mechanical Properties and Reactivity of Solids.	**3L**
.	3.2.3 Plane defects- Grain boundaries and Stacking faults Defect clusters, interchanged atoms; Extended atom defects-crystallographic shear structures, subgrain boundaries and antiphase domains.	**5L**

Reference books:-

1. L. E. Smart and E. A. Moore, Solid State Chemistry-An introduction, 3rd edition, Taylor and Francis, 2005.
2. A.R.West, Solid State Chemistry and Its Applications, John Wiley & sons, 1987.
3. C.N.R. Rao and J.Gopalkrishnan New Directons in Solid State Chemistry, 2nd Ed., Combridge University Press. 1997
4. L.V. Azaroff, Introductionn to solids, Tata-McGraw Hill Book Ce. New Dehli, 1977.
5. D.W. Bruce and Dermont O Hare, Inorganic Chemistry, 2nd Ed. Wiely and sons, New York, 1966.
6. J.M. Hollas, Symmetry in Molecules, Chapman adn Hall Ltd.,1972.
7. Ulrich Muller, Inorganic structural Chemistry, 2nd edition, John Wiley and Sons, Chichester, 1993.
8. R.N.Kutty and J.A.K.Tareen, Fundamentals of Crystal Chemistry, Universities Press (India) Ltd., 2001
9. H.V.Keer, Principles of the Solid state, Wiley Eastern Ltd., 1993. Gary L.Miessler and Donald A.Tarr, Inorganic Chemistry, 3rd edition , Pearson Education, Inc., 2004.
10. D.K.Chakraborty, Solid State Chemistry, New Age International Publishers, 1996.

PROGRAM(s): M.Sc.-II	SEMESTER: III				
Course code : WSCHIET631	**Course Title:** Applied Chemistry				
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (marks)**	**Semester End Examination (marks)**
02		**-**	**02**	**20**	**30**

Learning Objectives:

1. To study preparation, properties and uses of some widely used compounds.
2. Preparation and importance of Fertilizers, micronutrients, glass, paints and pigments.
3. To understand the various processes involved in extraction of metals and their alloys.

Course Outcomes: Students will able to

1. analyze the manufacture and applications of different ceramics and refractory materials, as well as various inorganic explosives.
2. apply the concept of the preparation and importance of fertilizers, micronutrients, glass, paints, and pigments in industries.

WSCHIET631 **Applied Chemistry**			
	Unit		**02 Credits/ 30 L**
	I	**Manufacture and Applications of Inorganic Compounds-I**	**15 L**
		1.1 Lime, Chlorine and Caustic soda, 1.2 Ceramics and refractory materials 1.3 Cement 1.4 Inorganic explosives (mercury fulminate, Lead azide)	
	II	**Manufacture and Applications of Inorganic Compounds-II**	**15 L**
		2.1 Fertilizers and micronutrients 2.2 Glass 2.3 Paints and Pigments	

REFERENCES:

1. G.M.Masters, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd. New Delhi, 1995.

2. Sulabha K. Kulkarni, Nanotechnology-Principles and Practices, Capital Publishing Co., 2007.

3. K. R. Mahadik and B. S. Kuchekar, Concise Inorganic Pharmaceutical Chemistry, Nirali Prakashan, Pune, 19 .

4. D. A. Skoog, D. M. West, and F. J. Holler, Fundamentals of Analytical Chemistry, 7 th Edition, (printed in India in 2001), ISBN Publication.

5. B. Douglas, D.H. McDaniel and J. J. Alexander, Concepts and Models of Inorganic Chemistry, 2nd edition, John Wiley & Sons, 1983.

OR

PROGRAM(s): M.Sc.-II		SEMESTER: III			
Course Code: WSCHIET632		**Course Title:** Inorganic Materials			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
02	**NA**	**-**	**02**	**20**	**30**

Learning Objectives:

1. To learn the techniques involved in separating the fission products from spent fuel by PUREX process.
2. To know the growing importance of nanomaterials.

Course Outcomes: Students will able to

1. Implement the concept of separating fission products from spent fuel using the PUREX process.
2. evaluate the application of nanomaterials across various fields.

WSCHIET632**- Inorganic Materials**			
	Unit	**Course/ Unit Title**	**02) Credits/ (30 L)**
	I	**Nuclear Chemistry and Inorganic Pharmaceuticals**	**15 L**
		1.1 Nuclear Chemistry : Introduction 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 1.2 Inorganic Pharmaceuticals : Radiopharmaceuticals containing Tc and Bi, contrast agents for X-ray and NMR imaging. 1.3 Gastrointestinal agents viz. (i) antacids (aluminium hydroxide, milk of magnesia, sodium bicarbonate and (ii) Cathartics(magnesium sulphate and sodium phosphate). 1.4 Topical agents viz. (i) protectives and adsorbents (talc, calamine), (ii) antimicrobial agents(potassium permanganate, tincture iodine, boric acid) and (iii)astringents (potash alum)	
	II	**Advances in Nanomaterials**	**15 L**
		2.1 Types of nanomaterials, e.g. nanotubes, nanorods, solid spheres, core-shell in nanoparticles, mesoporous materials; isolation of nano materials	

		2.2 Some important properties of nanomaterials: optical properties of metal and semiconductor nanoparticles, magnetic properties. 2.3 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. 2.4 Applications of nanomaterials in electronics, energy, automobiles, sports and toys, textile, cosmetics, medicine, space and defence. Environmental effects of nanotechnology	

REFERENCES:

1. G.M.Masters, Introduction to Environmental Engineering and Science, Prentice-Hall of India Pvt. Ltd. New Delhi, 1995.
2. Sulabha K. Kulkarni, Nanotechnology-Principles and Practices, Capital Publishing Co., 2007.
3. K. R. Mahadik and B. S. Kuchekar, Concise Inorganic Pharmaceutical Chemistry, Nirali Prakashan, Pune, 19 .
4. D. A. Skoog, D. M. West, and F. J. Holler, Fundamentals of Analytical Chemistry, 7 th Edition, (printed in India in 2001), ISBN Publication.
5. B.Douglas, D.H. McDaniel and J.J.Alexander, Concepts and Models of Inorganic Chmistry, 2nd edition, John Wiley & Sons, 1983.

PROGRAM(s): M.Sc.-II		SEMESTER: III			
Course code: WSCHIEP631		**Course Title :** Solvent Extraction / Analysis of samples-I			
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks 60)**	**Semester End Examination (Marks 60)**
NA	**04**	**-**	**02**	**20**	**30**

Learning Objectives:
1. To analyse the commercial samples for the active ingredients by solvent extraction method.
2. To analyse the commercial samples for the active ingredients.

Course Outcomes: Students will able to
1. conduct quantitative analysis of some metals by solvent extraction method.
2. conduct quantitative analysis of some metals by volumetric titration method.

	Practical	**02 Credits**
	Non-Instrumental:	
UNIT I	**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 5. Separation of Cu and Fe using n-butyl acetate and estimation of Cu	
UNIT II	**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. Nycil powder for its Zn content complexometrically.	

Reference books for practicals

1. A. I. Vogel, Quantitative Inorganic Analysis.
2. J. D. Woolins, Inorganic Experiments.
3. Palmer, Inorganic Preparations.
4. G. Raj, Advanced Practical Inorganic Chemistry.
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, (2013).

SEMESTER -IV

PROGRAM(s): M.Sc.-II	**SEMESTER: IV**				
Course code: SCHIMT641	**Course Title: Organometallics and main group Chemistry**				
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks 40)**	**Semester End Examination (Marks 60)**
04	**NA**	**–**	**04**	**40**	**60**

Learning Objectives:

1. To understand the fundamental principles involved in bonding in Organo-metallic compounds of d-block elements.
2. To give students a basic understanding of the synthesis and applications of organopalladium and platinum compounds.
3. To investigate the use of organometallic compounds as catalysts in a several organic homogeneous and heterogeneous reactions.

Course Outcomes: Student will able to

1. analyze the fundamental principles involved in bonding in organo-metallic compounds of d-block elements.
2. evaluate basic ideas regarding the synthesis and applications of organo palladium and platinum compounds.
3. explain the structure and bonding involved in inorganic cage, cluster, ring, and chain compounds. They will also study the use of organometallic compounds as catalysts in several organic homogeneous and heterogeneous reactions.

WSCHIMT641 **- Organometallics and main group Chemistry**			
Paper I	**Unit**	**Course/ Unit Title**	**04 Credits/ 60 L**
	I	**Organometallics Chemistry**	**15L**
		1.1.1 Metal-Metal Bonding and Metal Clusters, 1.1.2 Electron Count and Structures of Clusters, 1.1.3 Isolobal Analogy. 1.1.4 Organo Palladium and Organo Platinum Complexes (preparations, properties and applications.)	
	II	**Applications of Organometallic Compounds**	**15 L**
		1.2.1 Catalysis-Homogenous and Heterogenous Catalysis: Comparison, Fundamental Reaction Steps. 1.2.2 Organometallics as Catalysts in Organic Reactions: (i)Hydrosilation, (ii)Hydroborationn. (iii) Water gas Shifts Reaction (iv) Wacker process(Oxidation of alkenes) (v)Alcohol corbonylation 1.2.3 Coupling reactions : (i) Heck's reaction (ii) Suzuki reaction	

	III	**Inorganic cluster and cage compounds**	**15 L**
		1.3 (i) Introduction, (ii) Bonding in boranes,(iii) Heteroboranes, (iv) Carboranes, (v) cluster compounds, (vi) electron precise compounds and their relation to clusters.	
	IV	**Inorganic ring and chain compounds**	**15 L**
		1.4.1 Silicates, polysilicates and aluminosilicates, 1.4.2 Phosphazenes, phosphazene polymers 1.4.3 Polyanionic and polycationic compounds	

REFERENCES:

1. Gary Wulfsberg, Inorganic Chemistry; Viva Books PA Ltd., New Delhi; 2002.
2. F.A. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd edition.
3. James E.Huheey, Inorganic Chemistry, 3rd edition, Harper & Row,Publishers, Asia, Pte Ltd., 1983.
4. W.W.Porterfield,Inorganic Chemistry-An Unified Approach,Academic press(1993);
5. D.F.Shriver, P.W.Atkins and C.H. Langford, Inorganic Chemistry,3rd edition Oxford University Press, 1999.
6. Asim K.Das, Fundamental Concepts of Inorganic Chemistry,(Volumes-I,II and III)CBS Pub.(2000)
7. N.N.Greenwood and A.Earnshaw, Chemistry of Elements, Pergamon, 1984.
8. J.M.Hollas, Symmetry in Chemistry, Chapmanad Hall Ltd., NY, 1972.
9. F.A.Cotton, Chemical Applications of Group Theory, 2nd edition, Wiley Eastern Ltd., New Delhi , 1976
10. C.J.Ballhausen and H.B.Gray, Molecular Orbital Theory, MCGraw-Hill, New York, 1965.
11. H. Sisler, Chemistry in Non-aqueous Solvents: New York Reinhold Publ. 1965.
12. J.J. Lagowski, The Chemistry of Non-aqueous Solvents, Academic press, New york and London.
13. C.M. Day and Joel Selbin, Theoretical Inorganic Chemistry,Affiliated East West Press Pvt.Ltd., 1985.
14. L.E.Orgel, A Introduction to Ligand Field Theory, Methuen & Co.Ltd., London, 1960.
15. F.Basolo and R.G.Pearson, Mechanisms of Inorganic Reactions,Wiley, New York, 1967.
16. J.D.Lee, Concise Inorganic Chemistry, 5th ed., Blackwell ScienceLtd., 2005.
17. R.H. Crabtree, The Organometallic Chemistry of the Transition Metals, Wiley-Interscience, New york, 1988.
18. G.W.Parshall and S.D.Ittel, Homogeneous Catalysis, 2nd edition,John Wiley & sons, Inc., New York, 1992.
19. Gary O. Spessard and Gary L.Miessler, Organometallic Chemistry,Prentice-Hall, (1997).
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22. James E.Huheey, Inoganic Chemistry-Principles of structure and reactivity, edn Harper & Row Publishers (1972).
23. F. A. Cotton, G. Wilkinson, C. Murillo and M. Bochmann,Advanced Inorganic Chemistry, 6th ed., John Wiley, New York,1999.
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PROGRAM(s): M.Sc.-II		SEMESTER: IV			
Course Code:WSCHIMT642		Course title :Instrumental methods in Inorganic Chemistry and Group theory			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Assessment (CA) (Marks 40)	Semester End Examination (Marks 60)
04	NA	–	04	40	60

Learning Objectives:

1. To interpret IR and Raman spectra of inorganic molecules.
2. To have an understanding of basic principles and instrumentation with respect to ^{1}H, ^{19}F, ^{31}P, ^{11}B NMR.
3. Ability to choose the appropriate thermal technique based on the type of analyte and the desired qualitative and quantitative analytical information.

Course Outcomes: students able to

1. interpret IR and Raman spectra of inorganic molecules.
2. analyze the need for and challenges in the characterization of surfaces.
3. learn the instrumentation of various electron techniques.
4. demonstrate the ability to choose the appropriate thermal technique based on the type of analyte and the desired qualitative and quantitative analytical information. Additionally, students will learn the determination of thermodynamic properties using TGA and DGA.

WSCHEMT642 : Instrumental methods in Inorganic Chemistry and Group theory

	Unit	Course/ Unit Title	04 Credits/ 60 Lectures
	I	**Spectroscopy**	**15 L**
		2.1.1 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 $C_2O_4^{2-}$. 2.1.2 Raman spectroscopy: Raman spectroscopy for diatomic molecules. Determination of molecular structures like diatomic and triatomic molecules 2.1.3 Nuclear Magnetic Resonance Spectroscopy: Introduction to basic principles and instrumentation. Use of 1H, 19F, 31P, 11B NMR spectra in structural elucidation of inorganic compounds; Spectra of paramagnetic materials: Contact shift, application of contact shift, lanthanide shift reagent.	
	II	**Microscopy of Surface Chemistry**	**15 L**
		2.2.1 Introduction to surface spectroscopy, Microscopy, problems of surface analysis, distinction of surface species, sputter etching and depth profile and chemical imaging, 2.2.2. Ion Scattering Spectra (ISS),	

		2.2.3 Secondary Ion Mass Spectroscopy (SIMS), 2.2.4. Auger Emission Spectroscopy(AES) and 2.2.5. Electron Spectroscopy for Chemical Analysis . XPS /ESCA numerical problems Instrumentation and applications. 2.2.6 Instrumentation and applications of i) Scanning Electron Microscopy (SEM), ii) Atomic force microscopy (AFM) and iii) Transmission electron microscopy (TEM): Instrumentation and applications (numerical problems expected)	
	III	**Thermal Methods**	**15 L**
		2.3.1 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. 2.3.2 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. 2.3.3 Basic principle, instrumentation and applications to other thermal methods like Thermomechanical analysis (TMA) and evolved gas analysis (EGA)	
	IV	**Group theory and its applications**	
		2.4.1 Recapitulation of Points groups and Character tables, transformation properties of atomic orbitals; 2.4.2 Applications of group theory in: (i) infrared and Raman spectroscopy, (ii) construction of Molecular orbital diagram (tetrahedral AB_4 and octahedral AB_6 molecule involving both sigma and pi-bonding) (iii) Ligand Field Theory: Splitting of levels and terms in a chemical environment; Construction of energy level diagrams; 2.4.3 Methods of descending Symmetry; Correlation diagrams for d^2 ions in octahedral and tetrahedral ligand field. Hole formalism.	

REFERENCES:

1. G. H. Jeffery, J. Bassett, J. Mendham and R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis Fifth edition, (1996),ELBS Publication. Chapter 2, 3, 11.
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16. S. Glasstone, Sourcebook of Atomic Energy, East-West Publisher,1969.
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18. John H. Block, E.B. Roche, T.P.Soine and Charles O.Wilson, Inorganic Medicinal and Pharmaceutical Chemistry, Lea and Febiger, 1974.
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22. C.N.R. Rao, Chemical Applications of Infrared Spectroscopy Academic Pess, N.Y.(1963
23. K. Veera Reddy, Symmetry and Spectroscopy,
24. Paul Gabbott Principles and Applications of Thermal Analysis Wiley-Blackwell ; edition (2007)
25. Richard Vernon Parish, NMR, NQR, EPR, and Mössbauer spectroscopy in inorganic chemistry, Publisher,E,.Horwood,(1990)

Course Code : WSCHIMP641	**Course Code: Inorganic Practical -II**				
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks 40)**	**Semester End Examination (Marks 60)**
NA	**08**	**-**	**04**	**40**	**60**

Learning Objectives:

1. To open the ore with a suitable acid, then estimate the metal quantitatively using a gravimetric, volumetric, or colorimetric technique.
2. To use potentiometric method for determining the stability constant of zinc and silver complexes.
3. Determine the alkali metal content of electrical powder and fertiliser samples, as well as the salinity of sea water and the chloride content of fasting salt.

Course Outcomes: students able to

1. Open the ore using a suitable acid, followed by quantitatively estimating the metal using gravimetric, volumetric, or colorimetric techniques.
2. Understand the method for determining the stability constant of zinc and silver complexes using a potentiometer.
3. Calculate the CFSE of titanium and chromium complexes and the Racah parameter of nickel complexes from spectral data using a spectrophotometer.

Course code: WSCHIMP641 **-** Analysis of samples-II		**04 Credits**
	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	
	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 $[Ni(en)_3]^{2+}$	

	Separation and estimation of metal ions 1.Separation and estimation of Cu(II) and Zn(II) in a mixture using anion exchange resin. 2.Separation and estimation of Ni(II) and Zn(II) in a mixture using anion exchange resin. 3.Separation and estimation of Cu(II) and Ni(II) gravimetrically by forming salicylaldoximinato complexes at different pH.	

Reference books for practicals

1. A. I. Vogel, Quantitative Inorganic Analysis.
2. J. D. Woolins, Inorganic Experiments.
3. Palmer, Inorganic Preparations.
4. G. Raj, Advanced Practical Inorganic Chemistry.
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, (2013).

PROGRAM(s): M.Sc.-II	SEMESTER: IV
Course Code:WSCHIET641	**Course Title :** Intellectual Property Right

Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
02	**NA**	**–**	**02**	**20**	**30**

Learning Objectives:
1. To create awareness and understanding of terms like intellectual property, patents, copyright, industrial designs, trademarks, geographical indications etc.
2. To know trade secrets, IP infringement issues, economic value of intellectual property and study of various related international agreements.

Course Outcomes:
At the end of the Course student will be able-
1. describe the terms with their meaning such as intellectual property, patents, copyright, industrial designs, trademarks, geographical indications etc.
2. interpret various trades and their trade secrets.
3. summarize the different IP infringement issues, economic value of intellectual property.

WSCHIET641**- Intellectual Property Rights**			
	Unit	**Course/ Unit Title**	**02 Credits/ 30 L**
	I	**Introduction to Intellectual Property**	**15 L**
		1.1 Historical Perspective, Different types of IP, Importance of protecting IP.	**2L**
		1.2 Patents: Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Health care-balancing promoting innovation with public health, Software patents and their importance for India.	**5L**
		1.3 Industrial Designs:	**2L**
		Definition, How to obtain, features, International design registration. Copyrights: 1.4 Introduction, How to obtain, Differences from Patents.	**2L**
		1.5 Trade Marks: Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, trade names etc.	**2L**

		1.6 Geographical Indications: Definition, rules for registration, prevention of illegal exploitation, importance to India.	**2L**
	II	**Trade Secrets**	**15 L**
		2.1 Trade Secrets: Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade Secret Protection. 2.2 IP Infringement issue and enforcement: Role of Judiciary, Role of law enforcement agencies – Police, Customs etc 2.3 Economic Value of Intellectual Property: Intangible assets and their valuation, Intellectual Property in the Indian context – Various Laws in India Licensing and Technology transfer. 2.4.1 Different International agreements: (a) World Trade Organization (WTO): (i) General Agreement on Tariffs and Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade Related Services (GATS) Madrid Protocol. (iii) Berne Convention (iv) Budapest Treaty 2.4.2 Paris Convention: WIPO and TRIPS, IPR and Plant Breeders Rights, IPR and Biodiversity	

REFERENCES:

1. Andrew R. Leach & Valerie J. Gillet (2007) An Introduction to Cheminformatics. Springer: The Netherlands.

2. Gasteiger, J. & Engel, T. (2003) Cheminformatics: A textbook. Wiley–VCH

3. Gupta, S. P. QSAR and Molecular Modeling. Springer-Anamaya Pub.: New Delhi.

OR

PROGRAM(s): M.Sc.-II	SEMESTER: IV
Course code : WSCHIET642	**Course Title: Properties of Inorganic Solids**

Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
02	**NA**	**–**	**02**	**20**	**30**

Learning Objectives:

1. To describe the properties of inorganic materials in detail, including electrical, thermal, and magnetic properties.

Course Outcomes: students will able to

1. describe the properties of inorganic materials, including electrical, thermal, and magnetic properties.
2. expand their study to a wide range of inorganic materials, such as alloys, metals, metal oxides, and the magnetic and optical properties of materials. They will apply molecular orbital theory to understand the structure of cage and cluster compounds and metal sandwich compounds

WSCHIET642**- Properties of Inorganic Solids**

	Unit	Course/ Unit Title	02 Credits/ 30 Lectures
	I	**Electrical Properties**	**15**
		1.1 Electrical properties of solids: (i) Conductivity: Solid Electrolytes; Fast Ion Conductors; Mechanism of Conductivity; Hopping Conduction. 1.2 Band structures of metals, insulators, semi-conductors and inorganic solids; Applications of semiconductors (diodes, transistors, etc.) 1.3 Other Electrical Properties: Thermocouples and their applications, Thomson, Peltier and Seebeck effects; Dielectric, piezoelectric, pyroelectric and ferroelectric materials; their inter-relationship and applications.	
	II	**Magnetic, thermal and Optical Properties**	**15 L**
		2.1 Magnetic properties: Behaviour of substances in magnetic field, mechanism of ferromagnetic and antiferromagnetic ordering , superexchange, Hysteresis, Hard and soft magnets, structures and magnetic Properties of Metals and Alloys; Transition metal Oxides; Spinels; garnets, Ilmenites; Perovskite and Magneto plumbites and its applications.	

		2.2 Thermal Properties: Introduction, Heat Capacity and its Temperature Dependence; Thermal Expansion of Metals; Ceramics and Polymers and Thermal Stresses. 2.3 Optical properties: Color Centres and Birefringence; Luminescent and Phosphor Materials; Coordinate Model; Phosphor Model; Anti Stokes Phosphor; Ruby Laser; Neodymium Laser	

REFERENCE BOOKS

1. L. E. Smart and E. A. Moore, Solid State Chemistry-An introduction, 3rd edition, Taylor and Francis, 2005.
2. A.R.West, Solid State Chemistry and Its Applications, John Wiley & sons, 1987.
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Course Code : WSCHIEP641	**Course Code:** Analysis of samples-II				
Teaching Scheme					**Evaluation Scheme**
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Assessment (CA)**	**Semester End Examination**
NA	**04**	**-**	**02**	**20**	**30**

Learning Objectives:
1. Determine the alkali metal content of electrial powder, cement washing soda and fertiliser samples, as well as the salinity of sea water and the chloride content of fasting salt.
2.Interpretation of complex structure using spectral techniques.

Course Outcomes: students will able to
1. analyze the alkali metal content in electral powder and fertilizer samples, as well as the salinity of seawater, chloride content in fasting salt, and other commercial samples.
2. interpret the structure of complexes using spectral techniques.

WSCHIEP641 - Analysis of samples-II		**02 Credits**
UNIT I	Analysis of the following samples 1. Electral powder for Na/K content flame photometrically. 2. Fasting salt for chloride content conductometrically. 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. 6. Cement for its Iron content by redox titration. 7. Washing soda for its Na_2CO_3 content by pH metry.	
UNIT II	Spectral image interpretations XRD, FTIR, RAMAN, SEM TEM TGA	

Reference

1. A. I. Vogel, Quantitative Inorganic Analysis.
2. J. D. Woolins, Inorganic Experiments.
3. Palmer, Inorganic Preparations.
4. G. Raj, Advanced Practical Inorganic Chemistry.
5. J. E. House, Inorganic chemistry, Academic press, 2nd edition, (2013).

PROGRAM(s): M.Sc. II	SEMESTER: IV
Course: Dissertation	Course Code: WSCHIRP641 Course Title: Research Project

Teaching Scheme				Evaluation Scheme		
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Log book (Marks-30%)	Report (Marks-30%)	Via-Voc (Marks-40%)
-	12	–	06	45	45	60

Learning Objectives:

1. To understand and discuss the new research topics in the field of chemistry.
2. To display, organize and represent correlation between different types of data.
3. To summarize and provide a concise summary of research projects carried out.
4. Demonstrate a capacity to communicate research results clearly and comprehensively.
5. Ability to demonstrate oral/poster presentation.

Course Outcomes: At the end of the Course, learners able to

1. work and explain key research concepts and issues.
2. develop different experimental skills required for research.
3. Read, comprehend and anticipate the solution of research problems in their project work.
4. analyze data critically and validate its applications.
5. equip themselves with ethical issues related to Research and Publication.
6. communicate research findings in written and verbal forms.
7. develop a strong foundation for future research work in a systematic manner by applying notions of Research Methodology.

Detailed Syllabus:

Course Code	**WSCHIRP641-** Dissertation	**06 Credits**
	1. Students should carry out a detailed research project. 2. This should make them familiar with i. Literature survey, research methodologies ii. Data Analysis iii. Characterization techniques 3. Project report must be written and submitted in a proper format as follows; i. Certificate (Signed by Project guide and Head of the Department) ii. Certificates for Poster/Paper presented in conferences (if any) iii. Self declaration certificate for plagiarism iv. Introduction (not more than 6 pages) v. Experimental Section vi. Results and Discussions vii Conclusion viii. References (Use ACS format) ix. Spectroscopic or other relevant supporting data	

	x. Acknowledgement 4. Interdisciplinary projects shall be encouraged 5. Students should spend enough time for the project works (at least 12 hours per week) 6. If a student is performing a project in another institute, for such a student, an internal mentor must be allotted and he will be responsible for internal assessment of a student. In this case a student has to obtain a certificate from both external and internal mentors. 7. Systematic record of attendance of project students must be maintained by a mentor. 8. Project will be evaluated jointly by three examiners. 9. A student has to present his practical work, discuss results and conclusions in detail which will be followed by a question-answer session. 10. It is an open type of examination.	

Modality of Assessment (4 credit)

Theory Examination Pattern:

A. Internal Assessment- 40%- 40 Marks per paper

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**20**
	Total	**40**

B. External Examination- 60%- 60 Marks per paper Semester End

Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be 05 questions each of 15 marks on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I
Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	Sub Questions: 3A. 2 out of 4 3B. 1 out of 2	12	Unit III
Question	**Options**	**Marks**	**Questions Based on**
Q.4	Sub Questions: 4A. 2 out of 4 4B. 1 out of 2	12	Unit IV
Q.5	4 out of 8	12	Units (I+II+III+IV)
	TOTAL	**60**	

Modality of Assessment (2 credit)

Theory Examination Pattern:

C. Internal Assessment- 40%- 20 Marks per paper

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**10**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**10**
	Total	**20**

D. External Examination- 60%- 30 marks per paper Semester End Theory Examination:

1. Duration - These examinations shall be of **One hour** duration.
2. Theory question paper pattern:
   a. There shall be 03 questions each of 15 marks on each unit.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions Based on
Q.1	Sub Questions: 1A. 2 out of 4 1B. 1 out of 2	12	Unit I
Q.2	Sub Questions: 2A. 2 out of 4 2B. 1 out of 2	12	Unit II
Q.3	2 out of 4	06	Units (I+II)
	TOTAL	**30**	

Practical Examination Pattern:

A. **Internal Examination: 40%**

Particulars	Mandatory Practical (4 credit) Marks	Elective Practical (2 credit) Marks
Journal	**10**	**05**

Experimental tasks	**20**	**10**
Participation	**10**	**05**
Total	**40**	**20**

B. **External Examination: 60% Semester End Practical Examination:**

Particulars	**Mandatory Practical (4 credit) Marks**	**Elective Practical (2 credit) Marks**
Laboratory work	50	25
Viva	10	05
Total	**60**	**30**

Research Project / Dissertation Evaluation

Semester III (4 Credit)			**Semester IV (6 Credit)**		
Log book (Marks- 30%)	**Report (Marks- 30%)**	**Via-Voce (Marks- 40%)**	**Log book (Marks- 30%)**	**Report (Marks- 30%)**	**Via-Voce (Marks- 40%)**
30 Marks	30 Marks	40 Marks	45 Marks	45 Marks	60 Marks

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

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