Shivaji University, Kolhapur

Name of Department: Chemistry

Name of Programme: M.Sc Inorganic Chemistry

Vision: Engender Human Resource to Lead the Competitive Science World for Nation Building

Mission : Impart most advanced scientific knowledge and training to the students so that genuine researchers and skilled scientists of world standard will be made available for the advancement of national science and technology programs as well as to cater the needs of industrial and pharma sectors

Program Outcomes

PO1: Students will have a thorough knowledge in the fundamentals and application of modern chemical and scientific theories including those in all branches of Chemical sciences.

PO2: Students will be able to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments.

PO3: Students will be able to use the evidence based comparative chemistry approach for synthesis and analysis of the chemical compounds.

PO4: Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems.

PO5: Students will be able to clearly communicate the results of scientific task in oral and written formats. Students will be able to function as a member of an interdisciplinary problem solving team.

PO6: Students will be able to explain the role of Inorganic Chemistry for addressing social, economic, and environmental problems.

Program Specific Outcomes		
PSO1: The students will be able to get global level research opportunities to pursue Ph.D programme, targeted approach of competitive Exams such as CSIR – NET/GATE/SET, discipline specific competitive exams conducted by service commission, etc. **PSO2:** The students will be able to get employment opportunities in various industries like petrochemicals, metallurgical, materials and pharmaceutical, etc. **PSO3:** Understands the background of Inorganic reaction mechanisms, complex chemical structures, and instrumental methods of chemical analysis, separation techniques and analytical methods of general purpose. **PSO4:** Gains complete knowledge about all fundamental aspects of all the elements of chemistry.		
Course Outcomes		
Part-I Semester-I		
CH-1.1	**(Inorganic Chemistry – I)**	1. CO1: Students will be able to explain the basic chemistry of transition metals and its compounds, spectroscopic characteristics of such compounds, nomenclature, reactions and applications. CO2: Students will obtain knowledge about Preparation, structure, physical and chemical properties of metal carbonyls of transition metals. CO3: Students will be able to understand the all aspects of synthesis, bonding, structure and reactivity of organometallic compounds and their applications in homogenous catalysis. CO4: Student will be able determine the stability of the complexes and will be able to explain the nuclear stability and reactions.
CH-1.2	**(Organic**	CO1: Students will able to differentiate between various organic reactive intermediates.

	Chemistry – I)	CO2: Students can recognize, classify, explain, and apply fundamental organic reactions. CO3: Students will have ability to distinguish between different kinds of isomers. CO4: Course will develop interest in writing and finding mechanisms of new reactions. . .
CH-1.3	**(Physical Chemistry – I)**	CO1: Students will be able to understand basic principles of thermodynamics and statistical mechanics CO2: Able to learn advanced topics like quantum statistics and molecular dynamic simulation methods. CO3: Develop abilities to understand how to estimate and analyze the physicochemical properties of condensed and gas phase materials. CO4: Able to utilize spectral data to estimate molecular thermodynamic properties through partition function calculations. CO5: Understand properties of detergents and colloidal materials CO6: Learns the principles and techniques to understand gas and liquid adsorptions on solid surfaces CO7: Can learn spectral techniques to study surface adsorption phenomena. CO8: Learn principles and techniques for estimation of average molecular weight of a polymer or biological macromolecules

		CO9: Develop abilities to characterize polymers through understanding theories of virial coefficients, concepts of glass transition temperatures, etc.
CH.1.4:	**Analytical Chemistry-I**	CO1: Students would acquire the knowledge about the fundamentals of Analytical Chemistry including the sampling, sample pretreatment, basic techniques, methods and data handling, processing and statistical analysis of the same. CO2: Students would acquire the knowledge and understand the scope of Analytical Chemistry spanning various fields. The students will learn fundamentals of qualitative analysis using conventional techniques CO3: Students will learn the chromatographic techniques, choice of chromatographic techniques and tuning of the chromatographic technique as per the need based on the samples to deal with, learn electroanalytical techniques and computation chemistry which would groom them for alternative analytical strategies which form one of the important components of analytical chemistry. CO4: Students will learn about referring to the standard reference books and infer information from the same. Analytical case study problems would be discussed to familiarize with the scope and advantages of Analytical Chemistry.
PCH-1.1	**(Practical – I)**	CO1: Ability in professional sampling and sample treatment before actual analysis CO2: Ability to treat and evaluate the results of

		analysis CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)
PCH-1.2	**(Practical – II)**	CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc. CO2: Determine the rate constants of various first order and second order reactions CO3: Determine the redox potential of a system, relative strength of acid etc using potentiometer, conductometer CO4: Know the formation of alloys like Brass, Bronze, phase diagram for binary and ternary systems studied in details like a composition, critical temperature, etc CO5: Validity of Freundlich adsorption isotherms to remove toxic material such as dye, acetic acid, and other industrial effluents
Part-I Semester-II		
CH-2.1	**(Inorganic Chemistry – II)**	CO1: Students will get the knowledge of the basic chemistry of non-transition elements and their compounds, synthesis and structural features, and applications. CO2: To be able to explain the structures of inorganic compounds based on different theories. Student will understand the chemistry of various types of solvents. CO3: Be well versed with the knowledge about the

		chemistry of Lanthanides and Actinides with respect to occurrence, separation, compounds and applications. CO4**:** To understand the three dimensional structures of solid-state materials of industrial importance and to get the knowledge of bio-inorganic Chemistry.
CH-2.2	**(Organic Chemistry – II)**	**Course Outcomes (COs)** CO1: Illustration of modern synthetic methods and applications of reagents. CO2: Provide knowledge of different organometallic compounds and various coupling reactions. CO3: Understand principle and applications of protection and deprotection of various functional groups. CO4: It will elaborate to understand the concept of chemoselectivity, regioselectivity and enantioselectivity.
CH2.3	**(Physical Chemistry – II)**	CO1: Students will learn basics of quantum mechanics. CO2: Knowledge of the course will form the basis or essential requirement for the course "Advanced Quantum Chemistry" CO3: Able to understand selection rules and to predict the electronic spectra of conjugated organic molecules. CO4: Able to study photochemical and photophysical phenomena CO5: Capable of qualitative and quantitative analysis of various ingredients from industrial, food and pharma samples using techniques of emission

		spectroscopy. CO6: Capable of understand the electrochemical aspects of materials, ionic processes and electrochemical sensors, battery materials and characterizations etc. CO7: Able to study electrokinetic effects and their applications in the field of protein separation, characterization etc. CO8: Understanding the molecular dynamics through kinetic studies. Applications to explore reaction pathways, protein-ligand binding rates, etc. will help to understand life governing processes.
CH.2.4:	**Analytical Chemistry-II**	CO1: Students will acquire the knowledge of spectroscopic tools/instruments used in chemical analysis and interpretation of the data. The scope and limitations of the spectroscopic tools would be discussed so that the students learn about the type of samples which could be analyzed by these tools offering choices among the spectroscopic tools. CO2: Students will learn about the simple and advanced instruments used for analysis like NMR, MS, AAS, ICP and thermal analysis (TGA, DTA, DSC etc.) techniques spanning wide variety of samples to be considered for analysis. CO3: Students will learn about the instrumentation, sample preparation and handling of sample, analysis and data interpretation and structural elucidation. CO4: Learning about different instruments will give them idea about appropriate choice of the instrument for analysis based on the source and type of analyte(s) in the sample under consideration.

PCH-2.1	**(Practical – III)**	CO1: Students developed for precise sample solution preparation and sample treatment before actual analysis. CO2: Students can be able to perform the calculations and error analysis CO3: Develop understanding of basic chemical processes and deciding methods of analysis. CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, high end thermometers, refractometer, pH meter etc.)
PCH-2.2	**(Practical – IV)**	CO1: Students can be able to prepare various concentration solutions like molar, normal, ppm, etc. CO2: Determine the unknown concentration and thermodynamic parameters using conductometer CO3: Student will explore how to estimate order of reaction and the catalysis CO4: students can estimate refractive index and molecular weights of species. CO5: Students can understand the estimation of equilibrium properties like redox potential, phase diagram etc
Part-II Semester-III		
PCH-3.1	**(Inorganic Chemical Spectroscopy)**	**CO1:** At the end the student should be able to: Recognize symmetry elements in a molecule; State the point group a molecule belongs to; Combine matrices and set up matrix for transformations and acquisition of a theoretical support which underlies much of spectroscopy. **CO2:** Able to describe molecular vibration with the

		interaction of matter with light, Explain the basic concepts in IR and Raman Spectroscopy, Examines IR and Raman spectroscopy and molecular structure determination by the simple molecules. **CO3:** Students will be able to identify, describe and explain the function of the several components of a mass spectrometer and predict the fragmentation patterns expected. **CO4:** The ability to investigate and determine the local structure of typical elements in inorganic compounds and able to explain the surface composition and chemical nature of the surface elements.
ICH-3.2	**(Coordination Chemistry – I)**	CO1: To be able to describe and explain the bonding in d-metal complexes using crystal field and ligand field theories and calculate the crystal field stabilization energy and its role in stabilizing the complexes. CO2: At the end of the course students should be able to interpret simple electronic spectra and predict both position and intensity based on Orgel/Tanabe-Sugano diagrams and explain the spectroscopic properties of transition metal complexes. CO3: Students should be able to estimate the spin-only magnetic moment for given complex and predict the nature of magnetic properties. CO4**:** Students will be able to explain the reactivity and stabilities of ternary complexes and their reactions.
ICH- 3.3	**(Nuclear Chemistry)**	CO1: Students will be able to different modes of radioactive decay and also theories of

		radioactive decay. CO2: Students will be able to explain the nuclear structure and stability using various models. CO3: Students will get basic knowledge of nuclear reactions, mechanism and energy calculations. CO4**:** At the end students should be able to describe the fundamentals of nuclear reactors, isotopic chemistry, and the applications of radioactivity.
ICH3. 4	**(A) (Organometallic and Bioinorganic Chemistry)**	. CO1: After successful completion of the course the students should be able to explain the synthesis, structure, bonding, properties and reactivity of Alkyls and Aryls of Transition Metals. CO2: After successful completion of the course the students should be able to explain the synthesis, structure, bonding, properties and reactivity of Compounds of Transition Metal –Carbon with Multiple bonds. CO3: Students should be able to describe the role of metals in medicines, deficiency disorders of metals and use of platinum, gold and lithium compounds in the treatment of cancer, arthritis and psycho drugs, respectively. CO4**:** At the end of the course student should be able to explain the natural proteins that carry dioxygen in various animals, the role of myoglobin and hemoglobin in carrying dioxygen in mammals and other non-heme proteins for oxygen uptake.
ICH-3.4 (B)	**(Selected Topics in Inorganic Chemistry)**	CO1: Students will learn about the basic principles of catalysis. CO2: Students will get knowledge about the coordination polymers. CO3: After completion of the course students will be able to learn about the non-conventional sources of energy.

		CO4: Students will be able to understand the supra-molecular chemistry and the principles of it.
ICHP – V	**Practical-V**	CO1: Ability in professional sampling and sample treatment before actual analysis CO2: Ability to treat and evaluate the results of analysis CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory CO4: Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)
ICHP – VI	**Practical-VI**	**CO1:** Ability in professional sampling and sample treatment before actual analysis **CO2:** Ability to treat and evaluate the results of analysis **CO3:** Understanding and capability of performing basic chemical processes in a chemical laboratory **CO4:** Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)**COs – POs& PSOs mapping**
Part-II semester-IV		
ICH4.1	**(Instrumental Techniques)**	CO1: Students will obtain knowledge of the working principles involved for selective analytical methods and the fundamental basics of the instrumentation including electronic spectroscopy and diffraction techniques. CO2: Students will understand the advanced methods involved in determination of the quality and quantity of chemical substances in given compounds. CO3: At the end of the course students will learn the

		interpretation of the experimental data obtained using various techniques and instruments for laboratory analysis carried out for quality assurance. CO4**:** Students will be able to demonstrate the use of complementary analytical techniques to define the system/materials more precisely. To know the recent advancements in the instrumental methods of temperature programmed analysis.
ICH-4.2	**(Coordination Chemistry-II)**	CO1: After successful completion of the course students will be able to familiar with various reactions of transition metal complexes and will be able to predict the mechanism involved using direct and indirect evidences. CO2: At the end students will be able to explain the cis-effect, trans-effect, and mechanism of electron transfer reactions. CO3: Students will be able to explain the photochemistry of transition metal complexes. CO4: Students will be able to describe the industrial applications of transition metals as catalysts.
ICH-4.3	**(Chemistry of Inorganic Materials)**	CO1: At the end of the course students should be able to explain the bonding and structures of the solid state materials. CO2: After completion of this course students will be able to explain the various defects present in the solid-state materials and their impact on electronic and structural properties of the same. CO3: Students will be able to explain the various synthesis methods and advanced instrumentation tools used for characterization of nano-materials.

		CO4: At the end students will be able to explain the optical, magnetic and structural properties of the nanomaterials and will be able to explain their applications in various industrial fields such as Electronic devices, Energy generation and storage, Automobiles, Sports and toys, Textile Industries, Cosmetics Production, etc.**COs – POs& PSOs mapping matrix (1-low, 2-medium, 3-high, 0-No correlation)**
ICH-4.4	**(A) (Energy and Environmental Chemistry)**	CO1: At the end, students will be able to: Learn basic concepts of solid waste management, beginning from source generation to waste disposal. CO2: Students should be able to-Characterize the solid waste in terms of hazardous waste components; impact of waste management on health and environment; understand steps towards solid waste management-waste reduction at source, materials and resource recovery/recycling, treatment and disposal techniques. CO3: After completion of the course student will be able to explain the advanced energy conversion devices such as Fuel cells, and the various techniques involves in the production of Hydrogen (future fuel). CO4**:** Students will be able to demonstrate the reactions involved in the advanced energy storage devices, can predict the theoretical energy storage capacities of such devices, understand the chemistry of various batteries.
ICH-4.4	**(B) (Radiation Chemistry)**	CO1: The students will obtain knowledge about the isotopes and health hazards of

		radiation. CO2: Students will earn knowledge about the separation of radionuclides. CO3:Students will be able to understand the role of tracers in designing a reaction mechanism of certain reactions. CO 4: After successful completion of the course student will have knowledge about the detection and measurement of radioactivity.
ICHP – VII	**Practical-VII**	CO1: Ability in professional sampling and sample treatment before actual analysis CO2: Ability to treat and evaluate the results of analysis CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory CO4**:** Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes)
ICHP – VIII	**Practical-VIII**	CO1: Ability in professional sampling and sample treatment before actual analysis CO2: Ability to treat and evaluate the results of analysis CO3: Understanding and capability of performing basic chemical processes in a chemical laboratory CO4**:** Capability of performing measurements on basic analytical instruments (photometers, spectrometers, chromatographs, ion-selective electrodes
