

## Department:- M.Sc. (Chemistry)

### Programme Outcomes (POs)

PO-1	<p>After successful completion of two years programme in Chemistry a student should be able to</p> <ul style="list-style-type: none"><li>● Use modern instruments like spectrophotometer, flame photometer, nephelometer, colorimeter, pH meter and classical techniques such as chromatography, HPTLC to design experiments &amp; to properly record results of their experiments.</li></ul>
PO-2	<ul style="list-style-type: none"><li>● Demonstrate solve &amp; understand major concepts in all disciplines of chemistry</li></ul>
PO-3	<ul style="list-style-type: none"><li>● Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Chemical reactions.</li></ul>
PO-4	<ul style="list-style-type: none"><li>● Create awareness of the impact of chemistry on the environment, society &amp; development of outside the scientific community.</li></ul>
PO-5	<ul style="list-style-type: none"><li>● Follow proper procedures &amp; regulations for safe handling when using hazardous chemicals as well as regular chemicals.</li></ul>
PO-6	<ul style="list-style-type: none"><li>● Find a game full environment in industry, pharmaceutical industries, forensic laboratories, in schools, etc.</li></ul>

## Programme Specific Outcomes (PSOs)

PSO-1	<ul style="list-style-type: none"><li>• Gain knowledge of chemistry through theory &amp; practicals.</li></ul>
PSO-2	<ul style="list-style-type: none"><li>• Explain nomenclatures, structures, reactivity, stereochemistry, reaction mechanisms of chemical reaction, spectral analysis of various compounds.</li></ul>
PSO-3	<ul style="list-style-type: none"><li>• Identify chemical formulae, balance chemical reaction, and solve various numerical problems &amp; derivations.</li></ul>
PSO-4	<ul style="list-style-type: none"><li>• Use modern chemical tools, models, charts &amp; equipment.</li></ul>
PSO-5	<ul style="list-style-type: none"><li>• Understand good laboratory practices &amp; safety.</li></ul>
PSO-6	<ul style="list-style-type: none"><li>• Develop research oriented attitude &amp; skills.</li></ul>
PSO-7	<ul style="list-style-type: none"><li>• Develop research oriented deskill</li></ul>
PSO-8	<ul style="list-style-type: none"><li>• Create awareness &amp; handle the sophisticated instruments &amp; equipment.</li></ul>

## Course Outcomes (COs)

### SEMESTER-I

**COURSE CODE: PSCH101**

**COURSE NAME: CHEMISTRY PAPER I (Physical Chemistry)**

After successful completion of this course, students will be able to:	
CO-1	Calculate change in thermodynamic properties, equilibrium constants, partial molar quantities, chemical potential.
CO-2	Explain Third law of Thermodynamics, Entropy change for a phase transition, absolute entropies, determination of absolute entropies in terms of heat capacity, standard molar entropies.
CO-3	Understand and appreciate the advanced concepts of Classical Mechanics, failure of classical mechanics and of Need for Quantum Mechanics.
CO-4	Understand the application of quantum mechanics in different systems such as Free particle, Particle in a one, two and three dimensional box.
CO-5	Understand Composite Reactions, Steady state Approximation, rate determining steps, kinetics of inorganic mechanisms of formation and decomposition of different compounds.
CO-6	In depth knowledge of concepts of Kinetics of stepwise polymerization, Calculation of degree of polymerization for stepwise reaction
CO-7	Understand and apply the use of principles of electrochemistry

CO-8	In depth knowledge of Bio-electrochemistry and its applications.
------	--

**COURSE CODE: PSCH102**

**COURSE NAME: CHEMISTRY PAPER II (Inorganic Chemistry)**

After successful completion of this course, students will be able to:	
CO-1	Understand the principles of various bonding theories and identify the structure and bonding of simple molecules.
CO-2	Understand the various types of forces of attractions involved during bond formation.
CO-3	Understand and evaluate the concepts of Molecular Symmetry and Group Theory
CO-4	Understand application of Group Theory
CO-5	Recognize the various types of solid state packing and the types of chemical forces
CO-6	In depth knowledge of concepts of nanomaterials, their preparation and Applications in the field of semiconductors, solar cells.

CO-7	Understand the Formation, thermal studies, Conductivity measurements, electronic spectral and magnetic measurements, IR, NMR and ESR spectroscopic methods with respect to coordination compounds.
CO-8	To familiarize the learner with the determination of formation constants of metal complexes (Overall and Stepwise): Comparative studies of Potentiometric and spectral methods.

**COURSE CODE: PSCH103**

**COURSE NAME: CHEMISTRY PAPER III (Organic Chemistry)**

After successful completion of this course, students will be able to:	
CO-1	Upon completing the course, the students will be able to Identify the different types of reactive intermediates and appreciate their importance in organic reactions.
CO-2	Understand the various concepts related to acids and bases.
CO-3	Understanding the various mechanisms of organic reactions.
CO-4	Identify aromatic, non-aromatic and anti-aromatic compounds
CO-5	Understand and apply the concepts of stereochemistry

CO-6	Identify the chirality, axial and planar chirality, prochirality of different organic molecules.
CO-7	In depth knowledge of concepts like oxidation and reduction and their different types.
CO-8	Understanding the application of various oxidizing and reducing agents in organic conversions,

**COURSE CODE: PSCH104**

**COURSE NAME: CHEMISTRY PAPER IV (Analytical Chemistry)**

After successful completion of this course, students will be able to:	
CO-1	The students learn about language and the quality of analytical chemistry ,will able to solve analytical problems, to learn about to minimize errors , to learn about maintenance and calibration of instruments
CO-2	Understand types of instrumental methods, instruments for analysis, data domains, electrical and non-electrical domains, detectors, transducers and  Sensors, selection of an analytical method, accuracy, precision, selectivity, sensitivity, detection limit and dynamic range.

CO-3	The students understand the significance of Quality Management, types of quality standards for laboratories, total quality management, quality audits and quality reviews, and problems and the concept of accreditation of laboratories.
CO-4	Students will learn about Good Laboratory Practices (GLP) and Safety in Laboratories
CO-5	Understand and apply the concepts to solve calculations based on chemical principles
CO-6	To understand and apply the concepts of Oxidation number, rules for assigning oxidation number, redox reaction in term of oxidation number, oxidizing and reducing agents, equivalent weight of oxidizing and reducing agents, stoichiometry of redox titration.
CO-7	To learn about principle and instrumentation of Optical methods such as FT-technique, Molecular Ultraviolet and Visible Spectroscopy Infrared Absorption Spectroscopy
CO-8	The students learn about different types of Thermal Methods and the automation in chemical analysis

## SEMESTER II

**COURSE CODE: PSCH201**

**COURSE NAME: CHEMISTRY PAPER 1**

After successful completion of this course, students will be able to:	
CO-1	Understand the concepts and in depth knowledge of real gases, real solution and thermodynamic surfaces.
CO-2	Understand the bioenergetics, standard free energy change in biochemical reactions, exergonic, and endergonic. Hydrolysis of ATP, synthesis of ATP from ADP
CO-3	Solve the model problems in quantum mechanics and analyze the basis behind the postulatory method of quantum mechanics
CO-4	Application of the Schrödinger equation to two electron system, limitations of the equation, need for the approximate solutions, methods of obtaining the approximate Solution of the Schrödinger wave equation.
CO-5	In depth knowledge of Kinetics of reactions catalyzed by enzymes.
CO-6	Explain Kinetics of reactions in the Solid State:- Factors affecting reactions in solids, Rate laws for reactions in solid.



CO-7	Understand the types of Defects and Stoichiometry.
CO-8	Understand and appreciate the importance of Phase equilibria.

**COURSE CODE: PSCH202**

**COURSE NAME: CHEMISTRY PAPER II (Inorganic chemistry)**

After successful completion of this course, students will be able to:	
CO-1	Understand the importance of rate of reactions, factors affecting the rate of reactions, techniques for determination of rate of reaction in inorganic reactions.
CO-2	In Depth knowledge of Stereochemistry of substitution reactions of octahedral complexes.
CO-3	Understand the bonding , structure and applications of organometallic compounds
CO-4	Understand Eighteen and sixteen electron rule and electron counting with examples, Preparation and properties of different organometallic compounds
CO-5	Understand the importance of Conception of Heavy Metals, Toxicity of metallic species.

CO-6	Understanding the Sources and biological implication of radioactive materials. Effect of low level radiation on cells- Its applications in diagnosis and treatment, Effect of radiation on cell proliferation and Cancer.
CO-7	Understanding the Medicinal applications of different bioinorganic compounds.
CO-8	Utilize the principles of transition metal coordination complexes in understanding functions of biological systems.

**COURSE CODE: PSCH203**

**COURSE NAME: CHEMISTRY PAPER III (Organic chemistry)**

After successful completion of this course, students will be able to:	
CO-1	Evaluate the Generation of carbanion, kinetic and thermodynamic enolate formation, Regioselectivity in enolate formation, alkylation of enolates.
CO-2	Understanding the Mechanism of Acid and base catalyzed Aldol condensation, Mixed Aldol condensation with aromatic aldehydes, regiochemistry in mixed reactions of aliphatic aldehydes and ketones, intramolecular Aldol reaction and Robinson annulation.

CO-3	Understand and apply the Mechanisms, stereochemistry of different name reactions.
CO-4	Understand and evaluate the concepts of molecular orbitals, FMOs and their applications.
CO-5	Understand and evaluate the principle and applications of UV spectroscopy
CO-6	Understand and evaluate the principle and applications of IR spectroscopy
CO-7	Understand and evaluate the principle of Proton magnetic resonance spectroscopy, $^{13}\text{C}$ NMR spectroscopy
CO-8	Understand and evaluate the principle of Mass spectrometry, Structure determination involving individual or combined use of the above spectral techniques.

**COURSE CODE: PSCH204**

**COURSE NAME: CHEMISTRY PAPER IV (Analytical Chemistry)**

After successful completion of this course, students will be able to:	
CO-1	The students learn about principle of Chromatography techniques
CO-2	The students learn about different types of Chromatography techniques and its application
CO-3	Understand the principle, instrumentation and applications of X-ray spectroscopy, Mass spectrometry, Radioanalytical Methods
CO-4	Understand the principle, instrumentation and applications of different Radioanalytical Methods.
CO-5	Students will learn about various Surface Analytical techniques like Scanning Electron Microscopy (SEM), Scanning Tunneling Microscopy (STM), Transmission Electron Microscopy (TEM), Electron Spectroscopy (ESCA and Auger) and Atomic Spectroscopy
CO-6	Understand the principle of Atomic Spectroscopy, Advantages and Limitations of AAS, Atomic Spectroscopy based on plasma sources – Introduction, Principle, Instrumentation and Applications.

CO-7	To learn about principle and instrumentation of Electroanalytical techniques like Polarography
CO-8	Understanding the principle and applications of Electrogravimetry and Coulometry

## SEMESTER III

### MSc. II (Organic chemistry)

**COURSE CODE: PSCHO301**

**COURSE NAME: CHEMISTRY PAPER I (Theoretical organic chemistry-I)**

After successful completion of this course, students will be able to:	
CO-1	Have the core idea about advanced organic chemistry principles and theories to develop research oriented skills in applied organic chemistry.
CO-2	In depth knowledge about organic chemical reactions with a focus on principles for effective synthetic strategies.
CO-3	Understand the concept of different cycloaddition reactions, Electrocyclic reactions, Sigmatropic rearrangements, fundamentals of free-radicals, pericyclic chemistry.
CO-4	Understand the concept of fundamentals of free-radicals, pericyclic chemistry.
CO-5	Understand the classification of point groups based on symmetry elements
CO-6	Describe and apply stereochemical concepts such as Conformational analysis, Stereochemistry of fused ring and bridged ring compounds, and Anancomeric systems.

CO-7	Encompass achieved advanced knowledge about the interactions of Principles of photochemistry and Photochemistry of carbonyl compounds.
CO-8	Understand and study the Photochemistry of olefin, Photochemistry of arenes, Singlet oxygen and photo-oxygenation reactions, and Photochemically induced Radical Reactions. Chemiluminescence.

**COURSE CODE: PSCHO302**

**COURSE NAME: CHEMISTRY PAPER II (Synthetic Organic Chemistry-I)**

After successful completion of this course, students will be able to:	
CO-1	Understand the different Name reactions with mechanism and their application in organic chemistry
CO-2	Understand the multicomponent and click reactions
CO-3	Study the stability, reactivity, structural and stereochemical properties of different types of radicals.
CO-4	Understand and describe the characteristics of different free radicals and their involvement in the organic synthesis.
CO-5	Understand the concept and definitions of different enamines, their generation & application in organic synthesis.

CO-6	In depth knowledge about the Preparation and synthetic applications along with stereochemical aspects of ylides
CO-7	Have the core idea about Mechanism and regiochemistry of Mercury and Organoboron compounds in organic synthesis
CO-8	Have the core idea about Mechanism and regiochemistry of Organosilicones, Silyl enol ethers, Organotin compounds, and Selenium in organic synthesis.

**COURSE CODE: PSCHO303**

**COURSE NAME: CHEMISTRY PAPER III (Natural products and Spectroscopy)**

After successful completion of this course, students will be able to:	
CO-1	Understand the broad field of Natural Products Chemistry by reviewing the major classes of Natural Products compounds.
CO-2	Understand the structural features, structural elucidation, biological importance and applications of different Carbohydrate, Natural pigments, Insect pheromones, and Alkaloids.
CO-3	In depth knowledge on the biosynthesis of Multi-step synthesis of natural products.
CO-4	In depth knowledge of Prostaglandins, lipids and growth regulators.



CO-5	Understand the principle of Proton NMR.and Interpret the spectroscopic data of unknown compounds using Proton NMR.
CO-6	Understand the principle of <sup>13</sup> C –NMR spectroscopy:.and Interpret the spectroscopic data of unknown compounds using <sup>13</sup> C –NMR spectroscopy:.
CO-7	In depth knowledge of DEPT experiment, determining number of attached hydrogens, two dimensional spectroscopic techniques, COSY and HETCOR spectra, and NOE and NOESY techniques.
CO-8	Apply NMR, IR, UV-Vis spectroscopic (Including 2D technique) and Mass spectroscopy techniques in solving structure of organic molecules.

**COURSE CODE: PSCHOEC-I 304**

**COURSE NAME: CHEMISTRY PAPER IV (Medicinal, Biogenesis and green chemistry)**

After successful completion of this course, students will be able to:	
CO-1	To familiarize the learner with the Introduction, important terms used in medicinal chemistry.
CO-2	To explain the leaner about different procedures involved in drug design.
CO-3	To familiarize the learner with modern methods of drug design and synthesis.

CO-4	Understand the Concept of prodrugs and soft drugs, Synthesis and applications of various drugs.
CO-5	Understand the primary and secondary metabolites involved in different metabolic pathways.
CO-6	Describe the different pathways involved in biosynthesis of natural products
CO-7	Appreciate and apply the principles of green chemistry
CO-8	Differentiate between traditional and green processes, and understand the use of green catalyst in organic synthesis.

## SEMESTER IV

### MSc. II (Organic Chemistry)

**COURSE CODE: PSCHO401**

**COURSE NAME: CHEMISTRY PAPER I**

After successful completion of this course, students will be able to:	
CO-1	Explain the Structural effects and reactivity, Linear free energy relationship (LFER) in determination of organic reaction mechanism,
CO-2	Explain the Uses of Hammett equation, deviations from Hammett equation, Solvatochromism Z-scale, Spectroscopic Correlations, and Thermodynamic Implications.
CO-3	To make learners understand the Principles of molecular associations and organizations as exemplified in biological macromolecules like nucleic acids, proteins and enzymes.
CO-4	In depth knowledge of Synthetic molecular receptors, Molecular recognition and catalysis, molecular self- assembly. Supramolecular Polymers, Gels and Fibres.
CO-5	Describe and apply concepts such as Racemisation and resolution of racemates including conglomerates, Determination of enantiomer and diastereomer composition.
CO-6	Understand the Correlative method for configurational assignment, Molecular dissymmetry and chiroptical properties.

CO-7	Describe and apply the concepts such as Principles of asymmetric synthesis in organic reactions.
CO-8	Understand and apply Use of chiral auxiliaries in organic reactions.

**COURSE CODE: PSCHO402**

**COURSE NAME: CHEMISTRY PAPER II (Synthetic organic chemistry-II)**

After successful completion of this course, students will be able to:	
CO-1	Explain the concepts such as Protecting groups in Organic Synthesis, Concept of umpolung (Reversal of polarity):
CO-2	Understand the concept of Retrosynthetic analysis and synthetic planning.
CO-3	In depth knowledge about One group C-C Disconnections: with a focus on principles for effective synthetic strategies
CO-4	In depth knowledge about Two group C-C Disconnections: with a focus on principles for effective synthetic strategies
CO-5	In depth knowledge about Electro-organic chemistry.
CO-6	Understand the Applications of the Selected Methods of Organic synthesis such as Crown ethers, cryptands, micelles, cyclodextrins, Organocatalysts, Pd catalysed cycloaddition reactions, and Use of Sc(OTf) <sub>3</sub> and Yb(OTf) <sub>3</sub> in chemistry.

CO-7	Introduction to basic concepts: 18 electron rule, bonding in transition metal complexes.
CO-8	Understand the Application of Ni, Co, Fe, Rh, and Cr carbonyls, samarium iodide, and Ce(IV) in organic synthesis.

**COURSE CODE: PSCHO403**

**COURSE NAME: CHEMISTRY PAPER III (Natural products and heterocyclic chemistry)**

After successful completion of this course, students will be able to:	
CO-1	In depth knowledge of General structure, classification. Occurrence, biological role, important structural and stereochemical features of different steroids.
CO-2	Describe the Synthesis of cinerolone, jasmolone, allethrolone, exaltone and muscone.
CO-3	Understand the Classification, sources and biological importance and synthesis of different vitamins and antibiotics.
CO-4	Understand the Sources, structure and biological properties and synthesis of insecticides and Terpenoids:

CO-5	Have the core idea about the Introduction, classification, Nomenclature of monocyclic (3-6 membered) (Common, systematic (Hantzsch-Widman) and replacement nomenclature).
CO-6	Understand the Structure, reactivity, synthesis and reactions of heterocyclic compounds of monocyclic (3-6 membered) (Common, systematic (Hantzsch-Widman) and replacement nomenclature).
CO-7	Have the core idea about the Introduction, classification, Nomenclature of bicyclic/tricyclic (5-6 Membered) fused heterocycles (Common, systematic (Hantzsch-Widman) and replacement nomenclature).
CO-8	Understand the Structure, reactivity, synthesis and reactions of heterocyclic compounds of bicyclic/tricyclic (5-6 Membered) fused heterocycles (Common, systematic (Hantzsch-Widman) and replacement nomenclature).

**COURSE CODE: PSCHOOC-II 404**

**COURSE NAME: CHEMISTRY PAPER 4 (RESEARCH METHODOLOGY)**

After successful completion of this course, students will be able to:	
CO-1	Understand the Primary, Secondary and Tertiary sources of research.
CO-2	Understand the importance and use of Journal, Digital platforms, and Information Technology and Library Resources in research.

CO-3	To familiarize the learner with the system of The Investigative Approach such as Making and recording Measurements, SI units and their use, Scientific methods and design of experiments.
CO-4	To familiarize the learner with the different ways of Analyzing and Presenting research Data.
CO-5	To familiarize the learners with Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.
CO-6	Understand the concept of Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work, writing ethics, avoiding plagiarism.
CO-7	To make learners aware about the CHEMICAL SAFETY while carrying out any experiment in the chemistry lab.
CO-8	To make aware learners about the ETHICAL HANDLING OF CHEMICALS.

## SEMESTER III

### MSc. II (Analytical chemistry)

**COURSE CODE: PSCHA301**

**COURSE NAME: CHEMISTRY PAPER I (QUALITY IN ANALYTICAL CHEMISTRY)**

After successful completion of this course, students will be able to:	
CO-1	Understand the fundamentals of quality in analytical chemistry and the concept of sampling
CO-2	The students will be able to get a clear idea of the selection of methods for analysis and the method validation.
CO-3	Understand the concept of Measurement of uncertainty: interpretation of results and improving the quality of results.sources of noise in instrumentalSignal to noise enhancement, hardware devices for noise reduction, Software methods for noise reduction.
CO-4	To make students aware about Pharmaceutical Legislation:
CO-5	Understand and explain the principle of Ion exchange chromatography:chelating resins and their applications for separation of inorganic and organic compounds.
CO-6	Understand and explain the principle of Ion chromatography:Exclusion chromatography



CO-7	Understand and explain the principle of Supercritical fluid Chromatography
CO-8	Affinity Chromatography, Optimum pressure liquid chromatography

**COURSE CODE: PSCHA302**

**COURSE NAME: CHEMISTRY PAPER II (ADVANCED INSTRUMENTAL TECHNIQUES)**

After successful completion of this course, students will be able to:	
CO-1	Understanding the surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis.
CO-2	Understand and evaluate Surface Analytical Techniques: Preparation of the surface, difficulties involved in the surface analysis.
CO-3	Understanding the Advanced Electroanalytical Techniques:-Current Sampled (TAST) Polarography, Normal and Differential Pulse
CO-4	Understanding the Polarography, Potential Sweep methods- Linear Sweep Voltammetry and Cyclic voltammetry.
CO-5	Understand and evaluate the importance of Potential Step method- Chronoamperometry

CO-6	Understanding the Controlled potential technique- Chronopotentiometry , Stripping Voltammetry- anodic, cathodic, and adsorption, Chemically and electrolytically modified electrodes and ultra-micro electrodes in voltammetry
CO-7	To make students learn about different instrumental techniques, Chemiluminescence techniques, Chiroptical Methods : ORD, CD
CO-8	In depth knowledge of Photoacoustic spectroscopy, Spectroelectrochemistry

**COURSE CODE: PSCHA303**

**COURSE NAME: CHEMISTRY PAPER III (BIOANALYTICAL CHEMISTRY AND FOOD ANALYSIS)**

After successful completion of this course, students will be able to:	
CO-1	Explain the sources, classification, pollutants and permissible limits, Sampling methods for air, flew gas, Industrial Exhaust, stag Samples, Importance of automobile exhaust control and its limits, Sampling and analysis of: Particulate matter, aerosols, ammonia and organic vapors.
CO-2	Knowledge of Carbon credit and global issues related to air pollution. Greenhouse gases and their substitutes, Environmental Legislation: role of pollution control boards, article 48A and 51A, Motor Vehicle Act and method of analysis with  Respect to PUC.

CO-3	Understand and evaluate the importance of Water: quality and requirements of potable water, direct and indirect pollutants for potable water reservoirs, quality of potable water from natural sources, Bore well water quality and analytical parameters. Quality of bottled mineral water
CO-4	Understand and evaluate the importance Process of purification of bore well water to bottled mineral water, Regulatory requirements for packaged drinking water.
CO-5	Understand and evaluate the importance of soil pollution and Soil Analysis: sources of soil pollution and their control, sampling of soil, determination of water holding capacity, determination total nitrogen, ammonia and nitrates, fertility of soil and effect of pollution on it, synthetic fertilizers and their long term effect on soil quality, Noise Pollution: sources, effects, methods of measurements and control measures.
CO-6	Understand and evaluate the importance of Thermal Pollution: definition, source, impact, control measures, working of cooling towers and cooling ponds, involved economy, Radioactive pollutants: source, exposure hazards, precautions in handling and safety, Long term effects, Environmental Audits: concept of audit, authorities, evaluation methodology, benefits and certification.
CO-7	Understand and evaluate the importance of Insecticides, Pesticides: definition, classification of insecticides, pesticides. Biodegradation of insecticides and pesticides, Soaps and Detergents: classification and composition, qualitative analysis, quantitative analysis of detergents- alkalinity, active ingredients and oxygen releasing capacity. Biodegradable detergents.
CO-8	Understand and evaluate the importance of Petrochemical products: crude oils, fuels, and calorific values, fractional distillation process and fractions, properties of fuel, composition of fuel, flashpoint, fire point, corrosion test, carbon residue and impact on environment.

**COURSE CODE: PSCHAEC-I 304**

**COURSE NAME: CHEMISTRY PAPER IV (ENVIRONMENTAL AND CERTAIN INDUSTRIALLY IMPORTANT MATERIAL)**

After successful completion of this course, students will be able to:	
CO-1	Understand and evaluate the importance of General idea regarding the Pharmaceutical Industry, definition and classification of drugs, introduction to pharmaceutical formulations, and classification of dosage forms.  Role of FDA in pharmaceutical industries.
CO-2	Understand and evaluate the importance of Sources of impurities in pharmaceutical products and raw materials, Standardization of finished products and their characteristics, official methods of quality control.
CO-3	Understand and evaluate the importance of hods for analysis of drugs, assays involving chromatographic separations, proximate assays, assays of enzyme containing substances, biological and microbiological assays and tests. (8L
CO-4	Understand and evaluate the importance of Limit tests, solubility tests, disintegration tests, stability studies, impurity profile of drugs, bioequivalence and bioavailability studies, Polymers in pharmaceuticals and novel drug delivery systems.
CO-5	Understand and evaluate the importance of Analytical Chemistry in Forensic Science: General idea.  Understand and evaluate the importance of Forensic Analysis: Blood, DNA profiling, Hair analysis, Alcohol in body fluids, systematic drug identification.

CO-6	Understand and evaluate the importance of Analytical Toxicology: Isolation, identification and determination of Narcotics: Heroin, morphine and cocaine, Stimulants: Amphetamines and caffeine, Depressants: Benzodiazepines, Barbiturates and Mandrax, Hallucinogens: LSD and Cannabis.
CO-7	Understand and evaluate the importance of Cosmetics: Introduction. Evaluation of cosmetic materials, raw materials and additives. Formulation, standards and methods of analysis, Deodorants and antiperspirants: Al, Zn, Boric acid, chlorides, sulphates, hexachlorophene, methanamine, phenolsulphonates and urea.
CO-8	Understand and evaluate the importance of Hair tonic: 2,5-diaminotoluene, potassium borates, sodium perborate, pyrogallol, resorcinol, salicylic acid, dithioglycollic acid (in permanent wavers), Creams and Lotions: Types of emulsions, chloroform soluble materials, glycerol, pH emulsion, ash analysis, nonvolatile matter (IR spectroscopy).

## SEMESTER IV

### M.Sc II (Analytical Chemistry)

**COURSE CODE: PSCHA 401**

**COURSE NAME: CHEMISTRY PAPER I (QUALITY IN ANALYTICAL CHEMISTRY)**

After successful completion of this course, students will be able to:	
CO-1	Understand the membrane separation processes: operating principles and applications of microfiltration, ultra-filtration, reverse osmosis, dialysis and electro-dialysis.
CO-2	Understand and evaluate the Applications of Solvent extraction in Analytical Chemistry recapitulation of solvent extraction, roles of solvent extraction in analytical chemistry, solvent extraction in sample preparation and pretreatment steps, solvent extraction as a means of analytical determination
CO-3	Evaluate the separation, Analysis and Standardization of Herbal based products.
CO-4	Understanding Extraction of herbal materials: Choice of solvent for extraction, methods used for extraction and principals involved in extraction, Standardization of herbal formulation and herbal extracts, Standardization of herbal extract as per WHO cGMP guidelines, Physical, Chemical, Spectral and toxicological standardization, qualitative and quantitative estimations.

CO-5	Understanding the principle and concepts of green chemistry: sustainable development and green chemistry, atom economy, examples of atom economic and atom uneconomic reactions, reducing toxicity, Organic solvents: environmentally benign solutions, solvent free systems, supercritical fluids (only introduction) Ionic liquids as catalysts and solvents.
CO-6	Understand the Emerging Green Technologies: photochemical reactions (advantages and challenges), examples. Chemistry using microwaves, sonochemistry and electrochemical synthesis.
CO-7	Explain Electrophoresis: introduction, factors affecting migration rate, supporting media (gel, paper, cellulose, acetate, starch, polyacrylamide, agarose, sephadex and thin layers), Techniques of Electrophoresis: low and high voltage, sds-page, continuous electrophoresis, capillary electrophoresis, zone, gel, isoelectric focusing, isotachopheresis and micellar electrokinetic capillary chromatography, instrumentation, detection and applications.
CO-8	Introduction to Nanotechnology: Analytical techniques in nanotechnology, consequences of the nanoscale, (nanoparticles morphology, electronic structure, optical properties) one dimensional nanomaterials (nanofilms, nanolayers), two dimensional nanomaterials (nanotubes, nanowires), three dimensional nanomaterials (nanoparticles and quantum dots).

**COURSE CODE: PSCHA 402**

**COURSE NAME: CHEMISTRY PAPER II (ADVANCED INSTRUMENTAL TECHNIQUES)**

After successful completion of this course, students will be able to:	
CO-1	Understand the theory and Instrumentation- recapitulation, FT NMR, 2D NMR,- FID signal generation mechanism, Techniques in 2D NMR- homo nuclear correlation spectroscopy (COSY), total correlation spectroscopy (TOCSY), heteronuclear correlation (HETCOR)
CO-2	In depth knowledge of Radio waves in imaging- principle instrumentation and applications of MRI, Application of NMR to other nuclei C13, P31and F19 spectroscopy.
CO-3	Understand and explain the mass spectroscopy: recapitulation, correlation of mass spectra with molecular structure- interpretation of mass spectra, analytical information derived from mass spectra- molecular identification, metastable peaks, Fragmentation Reactions.
CO-4	Understand and explain the raman spectroscopy: Principle Theory Instrumentation techniques and Applications of Raman spectroscopy.
CO-5	Understand and explain the Activation analysis- NAA, radiometric titrations and radio-release methods.
CO-6	Understand and explain the Thermal analysis- Principle, Interfacing , instrumentation and Applications of (a) Simultaneous Thermal Analysis- TG-DTA and TG-DSC (b) Evolved gas analysis- TG-MS and TG-FTIR



CO-7	Understand and explain the concept of hyphenation, need for hyphenation, possible hyphenations.
CO-8	Understand and explain the interfacing devices and applications of GC – MS, ICP -MS, GC - IR, Tandem Mass Spectrometry, LC – MS: HPLC-MS, CE-MS.

**COURSE CODE: PSCHA 403**

**COURSE NAME: CHEMISTRY PAPER III (SELECTED TOPICS IN ANALYTICAL CHEMISTRY)**

After successful completion of this course, students will be able to:	
CO-1	Understand the importance and applications of Effluent treatment plant general construction and process flow charts, Treatment and disposal of Sewage, Effluent parameters for metallurgical industry, Permissible limits for metal (example Cr, As, Pb, Cd etc) traces in the effluent.
CO-2	Explain the recovery of metals from effluent, modern methods – Electrodialysis, Electrodeposition and Ion Exchange, Recycle and reuse of process and treated (effluent) water
CO-3	In depth knowledge of Solid waste management: objectives, concept of recycle, reuse and recovery, Methods of solid waste disposal, Treatment and disposal of sludge / dry cake.

CO-4	Understand and evaluate the importance of Managing non-decomposable solid wastes, Bio- medical waste : Introduction , Classification and methods of disposal
CO-5	Understand the Classification of plastic, determination of additives, molecular weight distribution, analysis of plastic and polymers based on styrene, vinyl chloride, ethylene, acrylic and cellulosic plastics..Metallic impurities in plastic and their determination, Impact of plastic on environment as pollutant, Paints and pigments: Types of paints pigments, determination of volatile and non - volatile components, Flash point (significance and method of determination), separation and analysis of pigments, binders and thinners.
CO-6	Evaluate the Role of Organo silicones in paints and their impact on environment..
CO-7	Understand and explain the dressing of ores, pollution due to metallurgical Processes (ore dressing, calcination, and smelting, Chemical analysis of ores for principal constituents: Galena, Pyrolusite, Bauxite, Hematite, and Monazite.
CO-8	Understanding Alloys: definition, analysis of Cupronickel, Magnesium, Steel And Stainless Steel, Bronze, Gun metal, Techniques of purification: Zone refining, analysis of high purity materials like s i l i c o n, vacuum fusion and extraction techniques.

**COURSE CODE: PSCHAOC-II 404**

**COURSE NAME: CHEMISTRY PAPER IV (RESEARCH METHODOLOGY)**

After successful completion of this course, students will be able to:	
CO-1	Understand the Primary, Secondary and Tertiary sources of research.
CO-2	Understand the importance and use of Journal, Digital platforms, and Information Technology and Library Resources in research.
CO-3	To familiarize the learner with the system of The Investigative Approach such as Making and recording Measurements, SI units and their use, Scientific methods and design of experiments.
CO-4	To familiarize the learner with the different ways of Analyzing and Presenting research Data.
CO-5	To familiarize the learners with Reporting practical and project work, Writing literature surveys and reviews, organizing a poster display, giving an oral presentation.
CO-6	Understand the concept of Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of  Scientific work, writing ethics, avoiding plagiarism.

CO-7	To make learners aware about the CHEMICAL SAFETY while carrying out any experiment in the chemistry lab.
CO-8	To make aware learners about the ETHICAL HANDLING OF CHEMICALS.