



"Education through self-help is our motto" - **KARMAVEER**

**Rayat Shikshan Sanstha's**  
**DAHIWADI COLLEGE, DAHIWADI**

**Tal. Man, Dist. Satara : 415 508**

[Arts, Science, Commerce, BCA, B.Voc.Agri.,  
Bank Management, Defence Studies & Vocational Education]

**Founder : Padmabhushan Dr. Karmaveer Bhaurao Patil D.Litt.**

[NAAC Third Cycle Reaccredited 'A' Grade (with CGPA 3.25)]

**Estd : 1965**

Jr.College No. J-21.06.001

M.C.V.C. No. J-21.06.901

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## **Master of Science (M. Sc.)**

### **Department of Chemistry**

### **(Organic and Analytical Chemistry)**

### **Programme Outcomes (PO's)**

**After Completing M.Sc. programme the student will be able to:**

- PO1: Creative Thinking:** Students will be able to think creatively to propose novel ideas in explaining facts and figures or providing new solution to the problems in chemistry.
- PO2: Interdisciplinary Approach:** Students will realize how developments in any science subject helps in the development of other science .
- PO2: Personality Development:** Students will imbibe ethical, moral and social values in personal and social life leading to highly cultured, civilized personality and positive attitude.
- PO4: Skills in research and industrial field:** Students will build a scientific temper, attitude and will be able to learn the necessary skills to succeed in research or industrial field.
- PO5: Communication Skills:** Students will develop various communication skills such as reading, listening, speaking, etc., which we will help in expressing ideas and views clearly and effectively.
- PO6: Environmental monitoring:** Understand the issues of environmental contexts and sustainable development.

### **Program Specific Outcomes (PSO's)**

- PSO1:** Students will be able to prepare and qualify subject specific competitive exams like NET,SET and GATE and also other general public administration exams like M.P.S.C. and U.P.S.C.etc. exams.
- PSO2:** Student will be able to utilize the knowledge and analytical skills in QA-QC and R&D departments in almost all the industries enabling them to secure jobs where analytical chemistry is the core requirement to ensure and ascertain the quality of the product.

**PSO3:** Students will have opportunity for higher education leading to Ph.D. program.

**PSO4:** Students will be able to explore contemporary research in chemistry and allied fields of science and technology, collaborate in team projects, communicate the results of scientific work in oral, written and electronic formats to both scientists and the public at large.

**PSO5:** Students can start their own laboratories/startups/ chemical industry/ business (entrepreneurship).

**PSO6:** Students will be able to interpret data from the state of art Analytical instruments For ascertaining the product/material.

### Course Outcomes (CO's)

#### Sem I CH-101: Inorganic Chemistry-Paper I

**CO1:** Understand wave nature of electron, wave equation, particle in one dimensional box.

**CO2:** Understand VSEPR theory, geometry and shape of the molecule

**CO3:** Study of transition elements their properties & Coordination chemistry, Learn bioinorganic chemistry.

**CO4:** Understand electrical & optical behavior of inorganic material & their application.

#### CH -102 : Organic Chemistry Paper II

**CO5:** Understand structure, generation, reactivity, & stability of reactive intermediate.

**CO6:** Understand SN1, SN2 and SNi mechanism with respect to mechanism & stereochemistry.

**CO7:** Understand aromatic electrophilic & nucleophilic substitution reaction

**CO8:** Understand reaction, mechanism & applications of E1, E2, E1Cb & some named reactions.

**CO9:** Understand stereochemical principles, enantiomeric relationship R and S, E and Z, stability reactivity of cyclohexene derivative

**CO10:** Compare the difference between types of addition, elimination and substitution reaction.

**CO11:** Learn and solve problem type of elimination

#### CH-1: 103: Physical Chemistry Paper III

**CO12:** Understand the thermodynamic of ideal & non ideal solution, Maxwell relation, thermodynamic equation of state, Gibbs-Duhem equation & its application to study of partial molar quantities.

**CO13:** Understand the statistical thermodynamics and various partition functions.

**CO14:** Study of basic terms related to surface phenomena & its applications.

**CO15:** Understand the terminology of biophysical chemistry its thermodynamics & Michaelis-Menten equation,

#### CH-IV: Analytical Chemistry-I Paper IV

**CO16:** Know the different types of errors, accuracy, precision treatments and different terms of analytical chemistry and types of sampling of matter.

**CO17:** Know terms, types, preparation, characterizations and applications of nanomaterials.

**CO18:** Know the different types of chromatographic techniques and its applications.

**CO19:** Know theory, instrumentation and applications of polarography and amperometry.

**CO20:** Know use of hardware and software, data representation, flow chart and writing simple programme like FORTRAN and C languages used in analytical chemistry

### **Practical M. Sc I Sem I (Practical-I)**

#### **CH-P-1 : Physical Chemistry Practical**

**CO21:** Determination of binary mixture of weak acids and strong acid by potentiometry.

**CO22:** determine concentration of acid and their strength in given mixture of acid by conductometry.

**CO23:** Inversion of cane sugar by polarimetry

**CO24:** partial molar volume of solvent.

**CO25:** Study of catalyst in chemical kinetics.

#### **Inorganic Chemistry**

**CO26:** know Ore analysis – ‘2’ ores

**CO27:** know alloy analysis – ‘2’ (Two and three components)

**CO28:** know Inorganic Preparations and purity of inorganic samples..

#### **Organic Chemistry Practicals**

**CO29:** Know One stage preparations involving various types of reactions Preparations, 1.Oxidation: Adipic acid by chromic acid oxidation of Cyclohexanol.

**CO30:** Aldol condensation: Dibenzal acetone from Benzaldehyde. 3.Sandmeyer reaction: p- Chlorotoulene from p-Toluidine. 4.Cannizzaro reaction: 4-chlorobenzyldehyde as a substrate.5.Aromatic Electrophilic substitutions: Synthesis of p-Nitroaniline and p- Bromoaniline. 6.Preparation of Cinnamic acid by Perkin's reaction.7.Knoevenagel condensation reaction 8.Coumarin Synthesis

**CO31:** know estimation of 1.Estimation of unsaturation. 2.Estimation of formalin. 3.Colorimetric Estimation of Dyes 4.Estimation of Amino acids

#### **Practicals in Analytical Chemistry. (Practical-II)**

**CO32:** know verify Beer-Lambert's Law for potassium permanganate solution and hence to determine the molar extinction coefficient and unknown concentration of given sample colorimetrically

**CO33:** know determination of the solubility of calcium oxalate in presence of KCl ( Ionic Strength Effect)

**CO34:** know determination of the solubility of calcium oxalate in presence of HCl ( H<sup>+</sup> ion Effect)

**CO35:** know of Analysis of Pharmaceutical tablets.

**CO36:** know verify the Beer-Lamberts Law and determine the concentration of given dye solution colorimetrically.

**CO37:** know estimation of the amount of D-glucose in given solution colorimetrically.

**CO38:** know determination of the acid value of given oil

**CO39:** Know determination of sodium from the fertilizer sample using cation exchange chromatographically.

**CO40:** Know determination of calcium from given drug sample.

**CO41:** know determination of hardness, alkalinity and salinity of water sample

**CO42:** know separation and estimation of chloride and bromide on anion exchanger.

#### **M.Sc.I Sem II**

#### **CH:V-Inorganic chemistry Paper V**

**CO43:** Learn mechanism in non transition metal complexes.

**CO44:** Learn of coordination chemistry of organometallic compounds & organic synthesis , 16 & 18 electron rule, factor affecting stability of metal complex

**CO45:** Understand the spectral magnetic properties & applications of lanthanide & actinides

**CO46:** Understand the nuclear reaction & chemical effect of nuclear transformation

### **CH-VI Organic Chemistry Paper VI**

**CO47:** learn various name reaction with example.

**CO48:** Study of alkylation & acylation of active methylene compounds & applications.

**CO49:** study of oxidation and reduction for solving the example.

**CO50:** understand protection of various functional group.

**CO51:** learn methodologies of organic synthesis & study of organometallic compound.

### **CH-P-VII: Physical Chemistry Paper VII**

**CO52:** Understand the terminologies and postulates of quantum mechanics, application electronic spectra of conjugated linear organic molecules.

**CO53:** Understand mechanics of particle in one, two and three dimensional box.

**CO54:** Study of basic concepts, Jablonski diagram & photochemical process.

**CO55:** Understand the terms ionic strength, activity coefficient, Debye limiting equation, Bjerrum Theory, acid & alkaline storage batteries.

**CO56:** Study of SSA & its applications, homogeneous & heterogeneous catalysis & its kinetics Paper.

### **CH-VIII: Analytical Chemistry- Paper VIII**

On completion of the course, M.Sc.I student will be able to

**CO57:** know basic terms, Woodward Fisher rule and calculation of  $\lambda_{max}$  in UV spectroscopy.

**CO58:** know basic terms, different types of vibrations, factors affecting IR frequencies and frequencies of different functional groups in IR Spectroscopy

**CO59:** know basic terminologies involved in NMR spectroscopy.

**CO60:** know basic terms, and fragmentation of organic compounds involved in Mass spectroscopy.

**CO61:** Learn Physical methods of structure elucidation which includes IR, UV, NMR & Mass Spectroscopy

**CO62:** Understand theory, instrumentation, working and application of Nephelometry and turbidometry.

**CO63:** Know the radiochemical analysis using NAA, GM, and scintillation counter.

### **CH-P-1 : Physical Chemistry Practical III**

**CO64:** Application of Onsager equation by conductometry.

**CO65:** Determine concentration of acid and their strength in given mixture of acid by conductometry.

**CO66:** Determine amount of halide in given mixture by conductometry.

**CO67:** Construction of phase diagram of mixture of solvent.

**CO68:** Study of catalyst in chemical kinetics.

**CO69:** Decomposition of  $H_2O_2$  and catalyst effect and rate constant.

### **CH:I & II: Practical Inorganic chemistry Practical III**

**CO70:** Perform Ore analysis gravimetrically and volumetrically

**CO72:** Analyze alloy gravimetrically and volumetrically

**CO73:** Prepare various inorganic complexes and determination of its Percent purity

### **CH-IV Practical course IV**

#### **Organic Chemistry Practical**

**CO74:** Know the technique of ternary organic mixture separation by using ether solvent.

**CO75:** Know the recovery of the separated organic compounds

**CO76:** Know the complete analysis of individual organic compound.

**CO77:** Know the confirmation of separated organic compound by preparing its derivatives.

**CO78:** Make use steam distillation assembly for Purification of organic compound.

**CO79:** know Ore analysis – ‘2’ ores

**CO80:** know alloy analysis – ‘2’ (Two and three components)

**CO81:** know Inorganic Preparations and purity of inorganic samples.

### **Organic Chemistry Practicles**

**CO82:** Know qualitative analysis: Separation and identification of the two component mixtures using Chemical and physical methods.

**CO83:** Know Thin layer chromatography (TLC).

**CO84:** Know Column chromatography and steam distillation techniques.

**CO85:** Know Determination of percentage of Keto-enol form.

**CO86:** Know Estimation of pesticides

**CO87:** Application of Onsagar equation by conductometry.

**CO88:** determine concentration of acid and their strength in given mixture of acid by conductometry.

**CO89:** Determine of amount of halide in given mixture by conductometry.

**CO90:** constriction of phage diagram of mixture of solvent.

**CO91:** Study of catalyst in chemical kinetics.

**CO92:** Decomposition of  $H_2O_2$  and catalyst effect and rate constant.

### **Practicals in Analytical Chemistry. Practical IV**

#### **Physical Chemistry Section**

**CO93:** know the estimation of the amount of  $NH_4Cl$  colorimetrically using Nessler’s Reagent.

**CO94:** know determination of the solubility of lead iodide in presence of varying concentration of salt  $KCl$ .

**CO95:** know determination of the solubility of lead iodide in presence of varying concentration of salt  $KNO_3$  (Any other experiments may be added)

#### **Organic Chemistry Section**

On completion of the course, M.Sc. I student will able to

**CO96:** know analysis of pharmaceutical tablets: Ibrufen / INAH

**CO97:** know Colorimetric estimation of drugs.

**CO98:** know Preparation of pesticides.

**CO99:** know column and thin layer chromatography

#### **Inorganic Chemistry Section**

On completion of the course, M.Sc. I student will able to

**CO100:** know determination of the amount of copper in brass metal alloy colorimetrically.

**CO101:** know the separation and estimation of Copper and Cobalt on cellulose Column.

**CO102:** know Separation and estimation of Nickel and Cobalt on a anion exchanger.

**CO103:** know Separation and estimation of Iron and aluminium on a cation exchanger.

#### **Physical Chemistry Section**

**CO104:** know the estimation of the amount of  $NH_4Cl$  colorimetrically using Nessler’s Reagent.

**CO105:** know determination of the solubility of lead iodide in presence of varying concentration of salt  $KCl$ .

**CO 206** know the determination of the solubility of lead iodide in presence of varying concentration of salt  $KNO_3$  (Any other experiments may be added)

### **M.Sc. II Organic Chemistry Sem III**

#### **Paper OCH-IX:Organic Reaction Mechanism**

On completion of the course, M.Sc. II student will able to

**CO107:** Compare the major and minor product of variety of organic reaction.

**CO108:** Understand accepted mechanism of organic reaction including all intermediates

**CO109:** Solve the problems on Taft and Hammet constant.

**CO110:** Understand Concave upward and downward deviation.

**CO111:** Learn the type's hydrolysis of ester.

**CO112:** Solve problems on photochemical reactions.

**CO113:** To understand the concept of pericyclic reactions.

**CO114:** To understand the kinetic & non-kinetic methods for reaction mechanisms.

### **Paper OCH-X: Advance Spectroscopic Methods**

On completion of the course, M.Sc. II student will able to

**CO114:** Understands basics terms, Woodward Fisher rule and calculation of  $\lambda_{\max}$  in UV spectroscopy.

**CO115:** Understands basics terms, different types of vibrations, factor affecting on IR frequencies and frequencies of various functional groups in IR spectroscopy

**CO116:** Understands basics terminologies involved and shielding deshielding, equivalent and non-equivalent protons in NMR spectroscopy.

**CO117:** Understands basics terms, and fragmentation of organic compounds involved in Mass spectroscopy.

**CO118:** Learn Physical methods of structure elucidation which includes IR, UV, NMR & Mass Spectroscopy

**CO119:** Solve the problems based on IR, UV, NMR, Mass Spectroscopy.

**CO120:** Analyze reaction sequences and differentiation by using spectroscopic technique.

### **Paper No. OCH-XI- Advanced synthetic methods**

On completion of the course, M.Sc. II student will able to

**CO121:** Understand retrosynthetic analysis of new organic molecules.

**CO122:** understand application of reagents and reaction in organic synthesis.

**CO123:** understand application of metal in organic synthesis.

**CO124:** understand Green synthesis and new methodology and use of instrument in organic synthesis,

### **Paper No. OCH-XII: Drug and Heterocycles**

**CO125:** To study concept of prodrug & soft drugs.

**CO126:** understand history & development of QSAR.

**CO127:** preparation of peniciline.

**CO128:** study of various antimalarial & antibacterial drugs.

**CO129:** Know the main synthetic routes and reactivity for variety of heterocyclic compounds and applications.

### **(Organic Practical Chemistry MSc II, Sem. III) Practical V and VI**

On completion of the course, M.Sc. II student will able to

**CO130:** Know qualitative Analysis Separation, purification and identification of compounds of binary mixture (one liquid and one solid) using the TLC and column chromatography, chemical tests. IR spectra to be used for functional group identification.

### **(Organic Practical chemistry MSc II, sem. III) Practical VI**

Quantitative analysis

**CO131:** know Three step Preparation

**CO132:** know Colorimetry and pH metry experiments.

### **Sem IV**

### **Paper No. OCH-XIII Theoretical Organic Chemistry**

On completion of the course, M.Sc. II student will able to

**CO133:** To Know concept of aromatic, anti-aromatic & non-aromatic compounds.

**CO134:** Classify the compounds into the above categories.

**CO135:** Learn the synthesis of various non-benzenoids aromatic compounds.

**CO136:** Understand the kinetic and thermodynamic control of reactions.

**CO137:** To understand the concept of non-classical carbocation..

**CO138:** To learn the mechanism involved in free radical reactions..

#### **Paper No. OCH-XIV Stereochemistry**

On completion of the course, M.Sc. II student will be able to

**CO139:** Understand New methods of stereo selective synthesis such as enantioselective synthesis of hydride donor, hydroboration, catalytic hydrogenation, Sharpless epoxidation, optical purity and enantiometric excess.

**CO140:** understand Stereochemistry of acyclic and alicyclic compounds, Conformation and reactivity in acyclic compounds and of cyclohexanes, Some aspects of the stereochemistry of ring systems, The shapes of the rings other than six membered

**CO141:** understand stereochemistry of the ring system, conformation and configuration, Fused and bridged rings fused bicyclic ring systems, O.R.D. and C.D.:Types of curves

**CO142:** understand Stereochemistry of compounds containing no chiral carbon atoms and diastereoisomerism (Geometrical isomerism)..

#### **Paper No. OCH-XV Natural Products**

On completion of the course, M.Sc. II student will be able to

**CO143:** Student able to classify the natural products: Terpenoids, alkaloids, steroids etc.

**CO144:** understanding introduction and structure determination of natural products like Alkaloids.

**CO145:** understanding introduction and structure determination of natural products like steroids.

**CO146:** understanding biogenesis of natural products.

#### **Paper No. OCH-XVI- Applied organic chemistry**

**CO147:** To study various carbamate & organophosphorous pesticides.

**CO148:** understanding introduction and structure of juvenile hormone.

**CO149:** study the application of vaniline.

**CO150:** study of manufacture of furfural from bagasse.

**CO151:** classification and synthesis of important dyes.

**CO152:** study of natural polymer & application of Oxo and Wacker process.

#### **CH-O2 (Organic Practical chemistry MSc II, sem. IV) Practical VII**

On completion of the course, M.Sc. II student will be able to

**CO153:** Separate organic compounds in different phases.

**CO154:** perform qualitative test to analyze functional group of organic compounds.

**CO155:** learn distillation technique.

**CO156:** detect elements N, S, and X in organic compounds.

**CO157:** use purification techniques of organic compounds.

**CO158:** understand two step synthesis of organic compound.

#### **CH-O2 (organic Practical chemistry MSc II) Practical VIII**

On completion of the course, M.Sc. II student will be able to

**CO159:** separate organic compounds in different phases.

**CO160:** perform qualitative test to analyze functional group of organic compounds.

**CO161:** learn distillation technique.

**CO162:** detect elements N, S, and X in organic compounds.

**CO163:** use purification techniques of organic compounds.

**CO164:** understand multistep synthesis.

**CO165:** Preparation of Project on selected topic.

#### **Course Outcomes**

## Part-II Semester-III

### ACH-3.1 (Advanced Analytical Techniques)

- CO166:** Develop knowledge of fundamental, instrumentation and working of state of art instrumental analytical techniques, effective use and choice of technique, written and/or oral communication of the concepts of analytical chemistry which will be useful as analytical chemist and R&D.
- CO167:** Acquire knowledge of mass spectrometry, type of MS, ionization types and specific Practical applications of MS.
- CO168:** Acquire knowledge of basics of nanochemistry, nanomaterials and nanotechnology and Application orientated synthesis and characterization of nanomaterials.
- CO169:** This course gives wide understanding about the instrumental analytical techniques (SEM, TEM,EDS, STM, AFM, Raman, XFS, ESR, XPS, AES, SIMS etc.)employed for qualitative and quantitative Analysis for contemporary research

### ACH-3.2 (Organic Analytical Chemistry)

- CO170:** Students will gain knowledge of the instruments used at the interface of Analytical-Organic Chemistry useful for R&D and structural elucidation using UV-Visible, IR,  $^1\text{H}$  &  $^{13}\text{C}$  NMR, Mass spectrometry data and interpretation of the same.
- CO171:** Students will acquire knowledge about the drug, their classification, sources of impurities(Chemical, atmospheric and microbial contamination) in pharmaceutical raw materials and analysis of the same.
- CO172:** Students will gain knowledge about the conventional and advanced analytical approaches For Analysis of drug, vitamin, body fluids and clinical samples.
- CO173:** Students will have an idea of commonly used pesticides and their analysis and also about Forensic Science and forensic sample analysis.

### ACH- 3.3: (Electroanalytical Techniques in Chemical Analysis)

- CO174:** Fundamental knowledge of electrochemistry, electrodes, types of electrodes, its construction Will Lay foundation for the course.
- CO175:** Students will gain knowledge and skill in electroanalytical techniques like cyclic voltammetry And its types, polarography, coulometry and dynamic light scattering technique for qualitative and Quantitative analysis.
- CO176:** Students will be familiar with the advanced electrodes used for chemical analysis, liquid-liquid membrane electrodes, enzymes and gas electrodes.
- CO177:** Students will learn about electrophoretic techniques, advances in electrophoresis techniques and its analytical applications.

### ACH-3. 4 ) (A) (Environmental Chemical Analysis and Control)

- CO178:** Students will acquire knowledge about sampling, criteria of good sampling, handling, Preservation And storage of the samples, pretreatment and post treatment of samples.
- CO179:** Students will acquire knowledge of conditions and strategies required during sampling and electrochemical and spectral methods for analysis of

environmental samples.

**CO180:** Students will learn about the air and water pollution, sources of pollution, typical parameters And properties (physical, chemical and biological) to be measured in air and water pollution with relevance to specific case studies. Students will be acquainted with organic pollutants and their analysis with special reference to pesticide analysis.

#### **ACH-3.4 ) (B) (Recent Advances in Analytical Chemistry)**

**CO181:** Students will be acquainted with ultra purity and ultra trace analysis required in electronic and semiconductor processing.

**CO182:** Students will learn Radio-Analytical techniques for analysis.

**CO183:** Student will be well versed with C13, P15 and O17 NMR Spectroscopy applications.

**CO184:** Student will learn about ESR spectrometry and its applications quantitative analysis. .

#### **ACHP – V Practical -V**

**CO185:** In-depth training on laboratory solution preparations on all concentration scales

**CO186:** Training on laboratory safety and lab ethics in scientific work

**CO187:** Training on planning, design and execution of experiments

**CO188:** Training on uncertainty estimations for experimentally measured and derived properties of solutions

#### **ACHP – VI Practical-VI**

**CO189:** Training on scientific literature search, defining the objective of the work, research skills, data representation in tabular and graphical form etc.

**CO190:** Training on experimental verification of fundamental theories, comparison of data with literature and scientific discussion on any deviation of data from expected theoretical values or reported literature.

**CO191:** Developing analytical skills

**CO192:** Training on qualitative and quantitative analysis of analyte.

#### **Part-II semester-IV**

##### **ACH 4.1 (Modern Separation Method in Analysis)**

**CO193:** Students will learn about modern separation and chromatographic used for analysis of different Type of samples.

**CO194:** The student will understand instrumentation and mechanism of various separation techniques.

**CO195:** Student will acquire knowledge regarding various choice of instrument and detectors to be used for analysis depending on the sample and matrix.

**CO196:** Student will learn fundamentals of extractive chromatography, types of extraction techniques, advances in extraction methods and their hyphenations with chromatography leading to addressing challenging problems in analytical chemistry.

##### **ACH-4.2 (Organic Industrial Analysis)**

**CO197:** Acquire knowledge of handling and investigating the characteristics of the oils,

fats, detergents and soap samples and analysis of the same providing opportunity in cosmetic, pharmaceuticals, dyes and polymers industries.

- CO198:** Student will gain knowledge and importance of food quality, probe for food adulteration and adulterants, food preservative, food flavors and analysis of their components.
- CO199:** Students will also gain knowledge about the animal food stuff and the additives added in the animal food stuff as antibiotics, dietary supplements and growth promoting drugs, preservatives etc. and analysis of the same.
- CO200:** Student will learn about the analysis of cosmetics, face powder, hair dyes and hair care products, types of cosmetics, precautionary measures and composition of the cosmetics and specific roles of the ingredients. Will acquire knowledge about the paints, pigments and petroleum products, composition and analysis of the same using conventional and instrumental techniques.

#### **ACH- 4.3 (Advanced Methods in Chemical Analysis)**

- CO201:** Students will be skilled in the techniques like fluorescence, phosphorescence, types of quenching, FRET and applications of the same in Analytical Chemistry and for addressing research problems.
- CO202:** Students will gain knowledge of the kinetic methods of analysis supporting the analysis and data procured in research.
- CO203:** The students will acquire the knowledge of advanced method of chemical analysis XPS, XRF, fluorescence and phosphorescence spectroscopy which will be beneficial in research.
- CO204:** Students will acquire knowledge of identifying types of plastic and will also be able to and determination of metallic impurities in plastics

#### **ACH-4.4 (A) (Industrial Analytical Chemistry)**

- CO205:** The students will acquire knowledge of analysis of metals, alloys, minerals and ores commonly Used in the industry.
- CO206:** The students will be acquainted with the analysis of real samples like cement, plaster of Paris, different commercial ores, soil composition, soil fertility, fertilizers etc using conventional and instrumental methods of analysis.
- CO207:** Students will also gain the knowledge of analysis of commercial materials, explosives, polymers, resins, rubber, luminescent paints, lubricants and adhesives.
- CO208:** These would offer opportunity to the students to get employment in industries for quality assurance and quality control (QA-QC) of the product.

#### **ACH-4.4 (B) (Quality Assurance and Accreditation)**

- CO209:** Students will acquire knowledge of QA-QC which is essential for analytical chemist, This covers a variety of chemical fields and this knowledge would help students working on various materials, understanding the basics of samples, sampling, sample storage, and pre-post treatment of samples.
- CO210:** Students will acquire knowledge of good laboratory practices, professional ethics, and instrumental analytical chemistry, awareness of health hazards, remedial measures, analytical method development and validation.
- CO211:** The students would be aware of the importance of documentation for raw materials and finished products, their monitoring, maintenance and

management. World-wide agencies involved in regulating the analytical protocols and establishing standards.

**CO212:** Students will gain knowledge about the quality assurance and accreditation, evolution and significance of quality management, available accreditation agencies and advantages of accreditation.

**ACHP – VIII Practical-VIII**

**CO213:** The students will acquire hands on training for conducting the representative experiments for the analysis of wide variety of samples of inorganic, organic and physical approaches by qualitative and quantitative analysis. Demonstrate professional and ethical attitude to serve the society

**CO214:** Students will have knowledge of safety signs on container of chemicals, safety in handling of chemicals, MSDS sheets, learn sample preparation and characterization for confirming the purity.

**CO215:** Students would acquire knowledge about the separation and estimation of amount of metal, metal ions, organic compounds etc. in given samples.

**CO216:** Based on the experience of project work, students will have ability to start their R & D laboratory