

# Sarsuna College

## Department of Chemistry

### Program Outcome, Program Specific Outcome and Course Outcomes under NEP: 2020

**“Education is what survives when what has been learned has been forgotten.” – B.F Skinner.**

#### UNDERGRADUATE SECTION

Model Reference: University of Calcutta, Syllabus for Honours (CCF)

Higher education plays an extremely important role in promoting human as well as societal well being and in developing India as envisioned in its Constitution - a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. Higher education significantly contributes towards sustainable livelihoods and economic development of the nation. As India moves towards becoming a knowledge economy and society, more and more young Indians are likely to aspire for higher education.

#### **Objectives**

The Undergraduate Curriculum Framework- 2022 (UGCCF) is meant to bring about systemic change in the higher education system in the University and align itself with the National Education Policy 2020.

The following objectives of NEP are kept in perspective while framing UGCCCF:

- to promote holistic development of students having the world view of a truly global citizen;
- to provide flexibility to students so that learners have the ability to choose their learning trajectories and programmes, and thereby choose their paths in life according to their talents and interests;
- to eliminate harmful hierarchies among disciplines/fields of study and silos between different areas of learning;
- multidisciplinary and holistic education to ensure the unity and integrity of all knowledge;

- to promote creativity and critical thinking and to encourage logical decision-making and innovation;
- to promote multilingualism and the power of language in learning and teaching;
- to impart life skills such as communication, cooperation, teamwork, and resilience;
- to promote outstanding research as a co requisite for outstanding education and development;

B.Sc. (Honours / Honours with Research) of 4 years' duration and 3 year under graduate B.Com degree are awarded by the University of Calcutta after successful completion of the course. During the course period, the University of Calcutta holds Eight examinations, namely Semester I, II, III, IV, V, VI, VII and VIII for B.Sc. (Honours / Honours with Research) and six semester examinations for 3 years B.Sc Courses. The syllabus of study consists of Discipline Specific Core Course / Major, Minor, AEC, SEC, Practical/ Tutorial, CVAC, IDC, Summer Internship and Research. B.Sc programme ensures students' knowledge in the field of current chemical industry, research area specially the cutting edge inter-disciplinary area the world is currently fascinated.

**The undergraduate (UG) programme of chemistry is composed of major, minor and interdisciplinary subjects. The syllabus is based on the national education policy (NEP) which covers almost all the fields of chemistry. The students will be enriched with plenty of knowledge after the completion of the course. The complete syllabus is compatible with the competitive examination for higher studies and research. In this programme there are various multidisciplinary courses. The students will acquire multidisciplinary skills which will be of tremendous value to them.**

## **Programme Learning Outcome (PLO):**

Learning outcomes can also be implemented at the program or institutional level to assess student learning over multiple courses, and to monitor whether students have acquired the necessary knowledge and skills at one stage to be able to move onto the next. Program learning outcomes will include subject-specific skills and generic skills, including transferable global skills and competencies, the achievement of which the students of a specific program of study should be able to demonstrate for the award of the certificate/Diploma/Degree qualification. The program learning outcomes would also focus on knowledge and skills that prepare students for further study, employment, and citizenship. They help ensure comparability of learning levels and academic standards across colleges/institutions. The achievement by students of course-level learning outcomes leads to the attainment of the program learning outcomes. Course-level learning outcomes will be aligned to program learning outcomes.

## **Program Learning Outcome for students (PO):**

**PLO 1.** Will be able to understand basic concept in different areas of chemistry.

**PLO 2.** Will be able to solve chemical problems with logical conclusion.

**PLO 3.** Find out the green route for chemical reaction for sustainable development.

**PLO 4.** Will able to get good laboratory practice with proper safety.

**PLO 5.** Able to demonstrate the experimental techniques and methods for chemical analysis, synthesis and important data collection and their interpretation.

**PLO 6.** Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.

**PLO 7.** To prepare the students for a successful career in industry and to motivate them for higher education and take up research as a career.

**PLO 8.** To develop an opportunity to work in interdisciplinary groups and in cutting edge research programmes.

### **Program Specific Outcome (PSO):**

**PSO 1.** Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

**PSO 2.** Will become familiar with the different branches of chemistry like analytical, organic, inorganic, physical, environmental, polymer, medicinal and biochemistry

**PSO 3.** Acquires the ability to synthesise, separate and characterize compounds using laboratory and instrumentation techniques.

**PSO 4.** To develop leadership and managerial skills promoting the need for lifelong learning as required for a competent professional.

**PSO 5.** To explain nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.

**PSO 6.** Identify chemical formulae and solve numerical problems.

**PSO 7.** Achieve the skills required to succeed in graduate school, professional school and the chemical industry like Cement industries, Agro product, Paint industries, Rubber industries, Petrochemical industries, Food processing industries, Fertilizer industries etc.

**PSO 8.** Understand the importance of the elements in the periodic table including their physical and chemical nature and role in the daily life.

# CHEMISTRY MAJOR

## SEMESTER -I

### PAPER : CHEM-H-CC1-1-Th

(Credit : Theory -03, Practical – 01)

### Fundamentals of Chemistry – I

#### Module : I

Topics	Outcome
Extra nuclear structure of atoms and Periodicity:	<ul style="list-style-type: none"><li>• Develop the clear concept of atomic structure, different atomic models, their merits and de-merits, idea of different quantum numbers.</li><li>• Learn about the GS term symbols.</li><li>• To learn the concept about extra-nuclear structures of atoms</li><li>• Understanding the fundamental concepts and principles</li></ul>

#### Module : II

### Basics of Organic Chemistry Bonding and Physical Properties:

Topics	Outcome
Valence Bond Theory : Electronic displacement : MO Theory : Stereochemistry- I :	<ul style="list-style-type: none"><li>• Develop the clear concept of Hybridisation.</li><li>• How hybridisation affects the different bond properties.</li><li>• Knowledge of effects of different Electronic displacements.</li><li>• Develop the concept of M.O theory.</li><li>• To develop concept of aromaticity based on M.O. theory.</li><li>• Knowledge of Frost Diagram.</li><li>• Idea of Homoaromaticity and</li></ul>

	<p>Antiaromaticity.</p> <ul style="list-style-type: none"> <li>• Concept of symmetry in a molecule.</li> <li>• Idea of different projection formulae.</li> <li>• Concept of Stereogenicity, Chirotopicity.</li> <li>• Idea of configurational nomenclature.</li> </ul>
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### Module : III

Topics	Outcome
<p>Thermodynamics -I : Chemical Kinetics-I:</p>	<ul style="list-style-type: none"> <li>• Students will gain an understanding of Concept Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics, concept of heat, work, internal energy and statement of first law; enthalpy, H; etc.</li> <li>• concepts on Rate law, order and molecularity.</li> </ul> <p>Extent of reaction; rate constants, order; Forms of rates of First, second and nth order reactions; Determination of order of a reaction by half-life and differential method; Rate determining step and steady-state approximation.</p> <p>Temperature dependence of rate constant; Arrhenius equation, energy of activation;</p>

## Practical

### PAPER : CHEM-H-CC1-1-P

Topics	Outcome
Acid-Base Titrations: Oxidation-Reduction Titrations:	<ul style="list-style-type: none"><li>• Develop the skills on manual titrations</li><li>• Acquire knowledge of separation and estimation of metal ions in a mixture</li><li>• Really helpful for industrial requirements as well as advance study</li></ul>

## SKILL ENHANCEMENT COURSE (SEC)

### Paper : CHEM-H-SEC1-1-Th

( Credit : Theory -03, Tutorial – 01)

### Quantitative Analysis and Basic Laboratory Practices

#### Module : I

Topics	Outcome
Introduction to Quantitative analysis and its interdisciplinary nature	<ul style="list-style-type: none"><li>• To gather basic knowledge about food chemistry, drugs and pharmaceuticals and surface chemistry</li><li>• Understanding the fundamental principles and techniques used in analytical chemistry.</li><li>• • Understanding the Importance of accuracy, precision and sources of error in analytical measurements</li><li>• . Knowledge of different parameters analyzed in water, such as pH, dissolved oxygen, and chemical</li></ul>

	contaminants. • • Understanding the principles and applications of chromatography in chemical analysis.
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### Module : II

Topics	Outcome
Titrimetric analysis: Acid-base titrimetry: Redox titrimetry: Precipitation titrimetry: Complexometric titrimetry: Gravimetric Analysis:	<ul style="list-style-type: none"> <li>Students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixture analysis and estimation of surface tension of commercial products.</li> <li>Qualitatively estimate anions and cations in samples.</li> </ul>

### Module : III

Topics	Outcome
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<p>Water analysis:  Water treatment technologies:  Basic laboratory practices:</p>	<p>Understanding the importance of water remediation and conservation in addressing water pollution and scarcity issues.</p> <ul style="list-style-type: none"> <li>• Understanding the different methods and technologies used in water remediation</li> <li>• Knowledge of the principles and applications of water treatment technologies</li> <li>• Understanding the importance of water conservation in sustainable water resource management.</li> <li>• Knowledge of different water conservation strategies</li> </ul>
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### **Tutorial**

#### **PAPER: CHEM-H-SEC1-1-Tu**

<b>Topics</b>	<b>Outcome</b>
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<ol style="list-style-type: none"> <li>1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares.</li> <li>2. Calibration of glassware, pipette, burette and volumetric flask.</li> <li>3. Preparation of TLC plates and separation of amino acids</li> <li>4. Calibration of instruments like colorimeter, pH-meter, conductivity meter, spectrophotometer using reference standards or reference materials.</li> <li>5. Conductometric titration between HCl and NaOH.</li> <li>6. Determination of alkali present in soaps/detergents.</li> </ol>	<ul style="list-style-type: none"> <li>• The students will have the knowledge and skills to determine the heat of neutralization, solubility of organic compounds by titration method.</li> <li>• They will be able to estimate different metal ions through gravimetric exercise. Spectroscopic and chromatographic exercise will train them to interpret the spectral data and chromatograms of organic compounds and will make them job ready for suitable industries.</li> <li>•</li> </ul>
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## SEMESTER -II

**PAPER : CHEM-H-CC2-2-Th**

**(Credit : Theory -03, Practical – 01)**

**Fundamentals of Chemistry - II**

Topics	Outcome
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<p><b>Module : I</b> Kinetic Theory and Gaseous state: Real gas and Virial equation:</p>	<ul style="list-style-type: none"> <li>• Students will gain an understanding of Concept of pressure and temperature; Kinetic molecular model of a gas behaviour of real gases compressibility factor; Boyle temperature, Wall collision and rate of effusion, Maxwell's distribution of speed and energy, Intermolecular forces like Debye, Keesom and interactions; Lennard-Jones potential</li> <li>• Understanding fundamental concepts and generic skills</li> </ul>
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Topics	Outcome
<p><b>Module : II</b>  Chemical Bonding – I: Theoretical principles of inorganic qualitative analysis:</p>	<ul style="list-style-type: none"> <li>• Comprehend the various aspects of different types of bonding between atoms.</li> <li>• Develop the clear concept of electrostatic interaction and electron sharing interaction.</li> <li>• Learn about the VBT and VSEPR theory.</li> <li>• Ideas of shapes and hybridizations of different molecules.</li> <li>• Develop the practical knowledge of weak force and non bonding interactions.</li> <li>• Acquire the theoretical knowledge of chemical test of cations and anions.</li> <li>• Extend the idea separation of ions</li> </ul>

	and their detections.
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Topics	Outcome
<b>Module : III</b>  Stereochemistry – II : General Treatment of Reaction Mechanism–I :	<ul style="list-style-type: none"> <li>• Develop the idea of reaction kinetics and reaction thermodynamics.</li> <li>• Knowledge of potential energy diagram of one step, two steps and three steps reactions.</li> <li>• Idea of K.C.P and T.C.P reactions.</li> <li>• Idea of Hammond's postulates.</li> <li>• Knowledge of carbocation, carboanion, radical.</li> </ul>

### Practical

#### PAPER: CHEM-H-CC2-2-P

Topics	Outcome
Qualitative semimicro analysis of mixtures containing three radicals. Emphasis should be given to the understanding of the chemistry of different reactions (only water /acid soluble salts) [Inorganic salts]:	<ul style="list-style-type: none"> <li>• Develop the practical knowledge of detection of different inorganic ions</li> <li>• Experienced the basic techniques of micro and semi micro analysis</li> <li>• Acquire knowledge of composition and estimation of ores and alloys</li> <li>• These aptitudes are very helpful for industrial requirements dealing with inorganic compounds, colour and paints, glass, silicates, metallurgy, fuel,</li> </ul>

	catalysts, chemicals.
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## **CHEMISTRY MINOR**

**PAPER : CHEM-H-CC1-1-Th Or CHEM-H-CC1-3-Th**

**(Credit : Theory -03, Practical – 01)**

### **SEMESTER-I**

**Chemistry Minor – I**

#### **Module : I**

<b>Topics</b>	<b>Outcome</b>
Extra nuclear structure of atoms and Periodicity:	<ul style="list-style-type: none"> <li>• Develop the clear concept of atomic structure Different atomic models, their merits and de merits, idea of different quantum numbers.</li> <li>• Learn about the GS term symbols.</li> <li>• Knowledge of electronic configurations.</li> </ul>

#### **Basics of Organic Chemistry Bonding and Physical Properties:**

<b>Topics</b>	<b>Outcome</b>
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<p><b>Module : II</b></p> <p>Valence Bond Theory :          Electronic displacement :          MO Theory :          Stereochemistry- I :</p>	<ul style="list-style-type: none"> <li>• Develop the clear concept of Hybridisation.</li> <li>• How hybridisation affects the different bond properties.</li> <li>• Knowledge of effects of different Electronic displacements.</li> <li>• Develop the concept of M.O theory.</li> <li>• To develop concept of aromaticity based on M.O. theory.</li> <li>• Knowledge of Frost Diagram.</li> <li>• Idea of Homoaromaticity and Antiaromaticity.</li> <li>• Concept of symmetry in a molecule.</li> <li>• Idea of different projection formulae.</li> <li>• Concept of Stereogenicity, Chirotopicity.</li> <li>• Idea of configurational nomenclature.</li> </ul>
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<b>Topics</b>	<b>Outcome</b>
<p><b>Module : III</b></p> <p>Thermodynamics -I :          Chemical Kinetics-I:</p>	<ul style="list-style-type: none"> <li>• Students will gain an understanding of Concept Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; Concept of heat, work, internal energy and statement of first law; enthalpy etc.</li> <li>• concepts on Rate law, order and molecularity. Extent of reaction; rate constant sand other releted fundamental concepts and indepth knowledge about the processes underlying the chemical concepts</li> <li>• Acquire generic skills and global competency in related fields of reearch and academia.</li> </ul>

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### **Practical**

#### **PAPER : CHEM-H-CC1-1-P Or CHEM-H-CC1-3-P**

<b>Topics</b>	<b>Outcome</b>
Acid-Base Titrations: Oxidation-Reduction Titrations:	<ul style="list-style-type: none"><li>• Develop the skills on manual titrations</li><li>• Acquire knowledge of separation and estimation of metal ions in a mixture</li><li>• Really helpful for industrial requirements as well as advance study</li></ul>

**Interdisciplinary Course in Chemistry**

**Paper: CHEM-H-IDC1-1-Th or CHEM-H-IDC2-2-Th**

**( Credit : Theory -02, Tutorial – 01)**

**Quantitative Analysis and Basic Laboratory Practices**

**Module : I**

<b>Topics</b>	<b>Outcome</b>
Introduction to Quantitative analysis and its interdisciplinary nature	<ul style="list-style-type: none"><li>• Students will able to employ critical thinking and scientific inquiry in the performance</li><li>• Design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program</li><li>• Undertake hands on lab activities that helps to develop practical knowledge and skills required for food, cosmetic, pharma, chemical, environment monitoring industry</li><li>• Recognize and appreciate the importance of chemical science and its application in broader inter-disciplinary fields</li></ul>

**Module : II**

<b>Topics</b>	<b>Outcome</b>
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<p>Titrimetric analysis:  Acid-base titrimetry:  Redox titrimetry:  Precipitation titrimetry:  Complexometric titrimetry:  Gravimetric Analysis:</p>	<ul style="list-style-type: none"> <li>• Students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixture analysis</li> <li>• Makes them future ready for conducting chemical analysis, investigation applying knowledge to seek solution to problems in the sub field of chemistry and other emerging inter disciplinary areas.</li> <li>• Acquire generic skills and global competency in related fields.</li> </ul>
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<b>Topics</b>	<b>Outcome</b>
<p><b>Module : III</b></p> <p>Water analysis:  Water treatment technologies:  Basic laboratory practices:</p>	<ul style="list-style-type: none"> <li>• Understanding the importance of water remediation and conservation in addressing water pollution and scarcity issues.</li> <li>• Understanding the different methods and technologies used in water remediation</li> <li>• Knowledge of the principles and applications of water treatment technologies</li> <li>• Understanding the importance of water conservation in sustainable water resource management.</li> <li>• Knowledge of different water conservation strategies</li> </ul>

	<ul style="list-style-type: none"><li>• Developing skills required for extraction, separation, identification in chemical and non chemical industries</li></ul>
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### **Tutorial**

**PAPER: CHEM-H-IDC1-1-Tu or CHEM-H-IDC2-2-Tu**

<b>Topics</b>	<b>Outcome</b>
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<ol style="list-style-type: none"> <li>1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in their handling, cleaning and drying of glass wares.</li> <li>2. Calibration of glassware, pipette, burette and volumetric flask.</li> <li>3. Preparation of TLC plates and separation of amino acids</li> <li>4. Calibration of instruments like colorimeter, pH-meter, conductivity meter, spectrophotometer using reference standards or reference materials.</li> <li>5. Conductometric titration between HCl and NaOH.</li> <li>6. Determination of alkali present in soaps/detergents.</li> </ol>	<ul style="list-style-type: none"> <li>• Students will have the knowledge and skills to understand the synthetic methods related to inorganic and organic fields.</li> <li>• Also, they can easily analyze the nitrogen containing compounds and separate the binary organic mixture.</li> <li>• Students will have the knowledge and skills to determine the heat of neutralization, solubility of organic compounds by titration method.</li> <li>• They will be able to estimate different metal ions through gravimetric exercise. Spectroscopic and chromatographic exercise will train them to interpret the spectral data and chromatograms of organic compounds and will make them job ready for suitable industries</li> </ul>
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### Three Year B Sc SEMESTER-1 AND II (Under CCF,2022)

**Paper : CHEM-MD-SEC**

**( Credits: Theory-03,Tutorial- 01)**

#### **CHEMISTRY IN DAILY LIFE**

Topics	Outcome
<b>Module: 1</b>  Dairy Products Food additives, adulterants and	.Develop an idea about the chemical compounds we deal with everyday  .Develop an awareness for avoiding the consumption of packaged food and processed

contaminants Artificial food colorants  <b>Module: 2</b> Vitamins Oils and fats Soaps and Detergents  <b>Module: 3</b> Renewable energy and polymer chemistry	food  . Helping the youth to stay fit  . Develop an idea about biochemistry  . The importance of having natural food over synthetic food  . Help to grow interest on biochemistry  • Knowledge of the types and properties of polymers and polymeric waste management  • Understanding renewable energy sources as a broader inter disciplinary area
<b>Tutorial</b> Estimation of Vitamin C Determination of Iodine number of oil Determination of saponification number of oil Determination of methyl alcohol in alcoholic beverages	. Acquire knowledge of the extent of adulteration in our daily food items  . Develop an idea of primary and secondary solution  . Develop an idea of different types of titrations  • Wide knowledge of industrial chemistry

## SEMESTER -II

**PAPER : CHEM-H-CC2-3-Th Or CHEM-H-CC2-4-Th**

**(Credit : Theory -03, Practical – 01)**

**Chemistry Minor – II**

Topics	Outcome
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<p><b>Module : I</b></p> <p>Kinetic Theory and Gaseous state: Real gas and Virial equation:</p>	<ul style="list-style-type: none"> <li>• Students will gain an understanding of Concept of pressure and temperature; Kinetic molecular model of a gas behaviour of real gases compressibility factor; Boyle temperature, Wall collision and rate of effusion, Maxwell's distribution of speed and energy, Intermolecular forces like Debye, Keesom and interactions; Lennard-Jones potential</li> <li>• In depth knowledge about the fundamental concepts and the underline principles</li> <li>• employ the relevent concept relevant to academia. Industry and broader inter-disciplinary subfields</li> <li>• Demonstrate procedural knowledge</li> </ul>
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Topics	Outcome
<p><b>Module : II</b></p> <p>Chemical Bonding – I: Theoretical principles of inorganic qualitative analysis:</p>	<ul style="list-style-type: none"> <li>• Comprehend the various aspects of different types of bonding between atoms.</li> <li>• Develop the clear concept of electrostatic interaction and electron sharing interaction.</li> <li>• Learn about the VBT and VSEPR theory.</li> <li>• Ideas of shapes and</li> </ul>

	<p>hybridizations of different molecules.</p> <ul style="list-style-type: none"> <li>• Develop the practical knowledge of weak force and non bonding interactions.</li> <li>• Acquire the theoretical knowledge of chemical test of cations and anions.</li> <li>• Extend the idea separation of ions and their detections.</li> <li>• Procedural knowledge required in pharmaceutical, chemical, teaching and research industry</li> <li>• Development of generic skills</li> </ul>
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Topics	Outcome
<p><b>Module III:</b> Stereochemistry – II : General Treatment of Reaction Mechanism–I :</p>	<ul style="list-style-type: none"> <li>• Develop the idea of reaction kinetics and reaction thermodynamics.</li> <li>• Knowledge of potential energy diagram of one step, two steps and three steps reactions.</li> <li>• Idea of K.C.P and T.C.P reactions.</li> <li>• Idea of Hammond's postulates.</li> <li>• Knowledge of carbocation, carboanion, radical.</li> </ul>

### Practical

**PAPER: CHEM-H-CC2-3-P Or CHEM-H-CC2-4-P**

Topics	Outcome
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<p>Qualitative semimicro analysis of mixtures containing three radicals.</p> <p>Emphasis should be given to the understanding of the chemistry of different reactions (only water /acid soluble salts) [Inorganic salts]:</p>	<ul style="list-style-type: none"> <li>• Develop the practical knowledge of detection of different inorganic ions</li> <li>• Experienced the basic techniques of micro and semi micro analysis</li> <li>• Acquire knowledge of composition and estimation of ores and alloys</li> <li>• These aptitudes are very helpful for industrial requirements dealing with inorganic compounds, colour and paints, glass, silicates, metallurgy, fuel, catalysts, chemicals.</li> <li>• Knowledge about industrial/ chemical factories and their functional areas</li> </ul>
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**NB.** Course-level learning outcomes are specific to a course of study within a given program of study. At the course level, each course may well have links to some but not all graduate attributes as these are developed through the totality of student learning experiences across the years of their study. A course framework would indicate the linkage between course learning outcomes and each program learning outcome. Individual programs of study will have defined learning outcomes which must be attained for the award of a specific certificate/diploma/degree.

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