Attributes of a Chemistry Graduate

Attributes of chemistry graduate under the outcome-based teaching-learning framework may encompass the following:

- **Core competency:** The chemistry graduates are expected to know the fundamental concepts of chemistry and applied chemistry. These fundamental concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent and time-bound revisions.
- **Communication skills:** Chemistry graduates are expected to possess minimum standards of communication skills expected of a science graduate in the country. They are expected to read and understand documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea/finding/concepts to wider audience.
- **Critical thinking:** Chemistry graduates are expected to know basics of cognitive biases, mental models, logical fallacies, scientific methodology and constructing cogent scientific arguments.
- **Psychological skills:** Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self- reflection, goal-setting, interpersonal relationships, and emotional management.
- **Problem-solving:** Graduates are expected to be equipped with problem-solving philosophical approaches that are pertinent across the disciplines;
- **Analytical reasoning:** Graduates are expected to acquire formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc.
- **Research-skills:** Graduates are expected to be keenly observant about what is going on in the natural surroundings to awake their curiosity. Graduates are expected to design a scientific experiment through statistical hypothesis testing and other *a priori* reasoning including logical deduction.
- **Teamwork**: Graduates are expected to be team players, with productive co- operations involving members from diverse socio-cultural backgrounds.
- **Digital Literacy:** Graduates are expected to be digitally literate for them to enroll and increase their core competency via e-learning resources such as MOOC and other digital tools for lifelong learning. Graduates should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.
- **Moral and ethical awareness:** Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.
- **Leadership readiness:** Graduates are expected to be familiar with decision- making process and basic managerial skills to become a better leader. Skills may include

defining objective vision and mission, how to become charismatic inspiring leader and so on.

Program Learning Outcomes (POs) in B.Sc (MAJOR) CHEMISTRY

The student graduating with the Degree B.Sc (Major) Chemistry should be able to

- **Core competency:** Students will acquire core competency in the subjectChemistry, and in allied subject areas.

(i) Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry and all other related allied chemistry subjects.
(ii) Students will be able to use the evidence based comparative chemistry approach to explainthe chemical synthesis and analysis.
(iii) The students will be able to understand the characterization of materials.

(iv) Students will be able to understand the basic principle of equipment, instruments used in the chemistry laboratory.

(v) Students will be able to demonstrate the experimental techniques and methods of their area ofspecialization in Chemistry.

- ***Disciplinary knowledge and skill***: A graduate student is expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.
- ***Skilled communicator***: The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.
- ***Critical thinker and problem solver***: The course curriculum also includes components thatcan be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.
- ***Sense of inquiry***: It is expected that the course curriculum will develop an inquisitive characteristic among the students through appropriate questions, planning and reporting experimental investigation.
- ***Team player***: The course curriculum has been designed to provide opportunity to act as teamplayer by contributing in laboratory, field based situation and industry.
- ***Skilled project manager***: The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring

knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

- ***Digitally literate***: The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, and use ofchemical simulation software and related computational work.
- ***Ethical awareness/reasoning***: A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.
- ***Lifelong learner***: The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

Course Learning Outcomes

The course learning outcomes are aligned with program learning outcomes but these are specific-to-specific courses offered in a program. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

In course learning outcomes, the student will attain subject knowledge in terms of individual course as well as holistically. The example related to core courses and their linkage with each other is stated below:

	Paper Code		
Programme Outcomes	**DSC/CC1**	**IDC1/IDC2**	**DSC/CC2**
Core competency	√	√	√
Critical thinking	√	√	√
Analytical reasoning	√	√	√
Research-skills	-	-	-
Team work	√	-	√

	Skill Enhancement Course(SEC)	
Programme Outcomes	**SEC1**	**SEC2**
Additional Knowledge enhancement	√	√
Exposure beyond discipline	√	√
Analytical reasoning	√	√
Digital Literacy	-	√
Moral and ethical awareness	√	√

Course Learning Outcomes(CLO)

Discipline Specific Core (DSC)

PAPER : CHEM-H-CC1-1-Th
(Credit : Theory -03, Practical – 01)

Fundamentals of Chemistry - I

Course learning outcome (COs)

On completion of this course, the students will be able to understand:

Learning objective:

1. **Extra nuclear structure of atoms and Periodicity**
2. **Basics of Organic Chemistry Bonding and Physical Properties:**
   Valence Bond Theory, Electronic displacement, MO Theory, Physical properties
3. **Stereochemistry**
4. **Thermodynamics**
5. **Chemical Kinetics**

PAPER : CHEM-H-CC1-1-P

(1) Calibration and use of apparatus.
(2) Preparation of primary standard solutions (Oxalic Acid and K2Cr2O7)

Acid-Base Titrations:

(3) Standardization of NaOH standard oxalic acid solution.
(4) Estimation of carbonate and bicarbonate present together in a mixture
(5) Estimation of acetic acid in commercial Vinegar.

Oxidation-Reduction Titrimetry:

(6) Standardization of KMnO4 standard oxalic acid solution.
(7) Estimation of Fe(II) using standardized KMnO4 solution.
(8) Estimation of Fe(III) using standard K2Cr2O7 solution.
(9) Estimation of Fe(II) and Fe(III) in a given mixture using standard K2Cr2O7 solution.

Paper : CHEM-H-SEC1-1-Th
(Credit : Theory -03, Tutorial – 01)

Quantitative Analysis and Basic Laboratory Practices

Course learning outcome (COs)

On completion of this course, the students will be able to understand:

Learning objective:

1. **Introduction to Quantitative analysis and its interdisciplinary nature**
2. **Titrimetric analysis**
3. **Acid-base titrimetry**
4. **Redox titrimetry**
5. **Precipitation titrimetry**
6. **Complexometric titrimetry**
7. **Gravimetric Analysis**
8. **Water analysis**
9. **Water treatment technologies**
10. **Basic laboratory practices**

PAPER: CHEM-H-SEC1-1-Tu

1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in
their handling, cleaning and drying of glass wares.
2. Calibration of glassware, pipette, burette and volumetric flask.
3. Preparation of TLC plates and separation of amino acids
4. Calibration of instruments like colorimeter, pH-meter, conductivity meter, spectrophotometer using reference
standards or reference materials.
5. Conductometric titration between HCl and NaOH.
6. Determination of alkali present in soaps/detergents.

Paper: CHEM-H-IDC1-1-Th/ CHEM-H-IDC2-2-Th

(Credit : Theory -02, Tutorial – 01)

Quantitative Analysis and Basic Laboratory Practices

Course learning outcome (COs)

On completion of this course, the students will be able to understand:

Learning objective:

1. **Introduction to Quantitative analysis and its interdisciplinary nature**
2. **Titrimetric analysis**
3. **Acid-base titrimetry**
4. **Redox titrimetry**
5. **Precipitation titrimetry**
6. **Complexometric titrimetry**
7. **Water analysis**
8. **Water treatment technologies**
9. **Basic laboratory practices**

PAPER: CHEM-H-SEC1-1-Tu

1. Safety Practices in the Chemistry Laboratory, knowledge about common toxic chemicals and safety measures in
their handling, cleaning and drying of glass wares.
2. Calibration of glassware, pipette, burette and volumetric flask.
3. Preparation of TLC plates and separation of amino acids
4. Calibration of instruments like colorimeter, pH-meter, conductivity meter, spectrophotometer using reference
standards or reference materials.
5. Conductometric titration between HCl and NaOH.
6. Determination of alkali present in soaps/detergents.

PAPER : CHEM-H-CC2-2-Th
(Credit : Theory -03, Practical – 01)
Fundamentals of Chemistry – II

Course learning outcome (COs)

On completion of this course, the students will be able to understand:
Learning objective:

1. **Kinetic Theory and Gaseous state**
2. **Real gas and Virial equation**
3. **Chemical Bonding –** Ionic bond, Covalent bond
4. **Stereochemistry**
5. **General Treatment of Reaction Mechanism**
   Reactive intermediates, Reaction thermodynamics, Reaction kinetics, Substitution Reaction

PAPER: CHEM-H-CC2-2-P
(1) Standardization of $Na_2S_2O_3$ solution against standard $K_2Cr_2O_7$ solution.
Iodo-/ Iodimetric Titrations
(2) Estimation of Vitamin C
(3) Estimation of (i) arsenite and (ii) antimony iodimetrically
(4) Estimation of available chlorine in bleaching powder.
Estimation of metal content in some selective samples
(5) Estimation of Cu in brass.
(6) Estimation of Cr and Mn in Steel.
(7) Estimation of Fe in cement

Paper : CHEM-H-SEC2-2-Th
(Credit : Theory -04)

AI for Everyone

Course learning outcome (COs)

On completion of this course, the students will be able to understand:
Learning objective:

1. **Introduction to Artificial Intelligence, Subfields and Technologies**
   - Definition and scope of AI
   - Historical overview and key milestones
   - Differentiating AI from human intelligence
   - Machine learning: Supervised, unsupervised, and reinforcement learning
   - Deep learning and neural networks
   - Natural language processing (NLP) and computer vision
2. **Applications of AI and Ethical and Social Implications of AI**
   - AI in healthcare: Diagnosis, treatment, and medical imaging
   - AI in finance: Fraud detection, algorithmic trading, and risk assessment
   - AI in transportation: Autonomous vehicles and traffic optimization
   - AI in customer service and chatbots
   - AI in education: Personalized learning and intelligent tutoring systems
   - Bias and fairness in AI systems
   - Privacy and data protection concerns
   - Impact of AI on employment and the workforce
   - AI and social inequality
3. **Other Important Issues**
   - Ethical guidelines and responsible AI practices
   - AI and Innovation
   - Emerging trends and future directions in AI
   - AI and creativity: Generative models and artistic applications