# FOUR YEAR UNDERGRADUATE PROGRAM (2024 – 28)
## DEPARTMENT OF CHEMISTRY
## COURSE CURRICULUM

| **PART- A: Introduction** | | | | |
|---|---|---|---|---|
| **Program: Bachelor in Science** *(Certificate / Diploma / Degree/Honors)* | | | **Semester - I** | Session: 2024-2025 |
| 1 | **Course Code** | **CHSC-01T** | | |
| 2 | **Course Title** | **FUNDAMENTAL CHEMISTRY-I** | | |
| 3 | **Course Type** | **DSC** | | |
| 4 | **Pre-requisite** (if, any) | ***As per Program*** | | |
| 5 | **Course Learning. Outcomes (CLO)** | ➢ *To know the contributions of ancient Indian scientists, study atomic structure, and periodic properties.*<br>➢ *To explore the concept of chemical bonding, including ionic and covalent bonding, hybridization, molecular orbital theory and intermolecular interactions.*<br>➢ *To learn about reaction mechanisms of inorganic reactions and their stoichiometry.*<br>➢ *To understand basics principles of organic chemistry.* | | |
| 6 | **Credit Value** | **3 Credits** | ***Credit = 15 Hours - learning & Observation*** | |
| 7 | **Total Marks** | **Max. Marks: 100** | | **Min Passing Marks: 40** |

**PART -B: Content of the Course**

**Total No. of Teaching–learning Periods (01 Hr. per period) - 45 Periods (45 Hours)**

| Unit | Topics (Course contents) | No. of Period |
|---|---|---|
| I | **A. Chemistry in Ancient India:** (a) Chemical techniques in ancient India: General Introduction (b) Contribution of ancient Indian scientists in chemistry, e.g., metallurgy, dyes, pigments, cosmetics, Ayurveda, Charak Sanhita.<br>**Ancient Indian Chemist-** Their Contribution and Books- Rishi Kanad, Aacharya Nagarjuna, Vagbhatta, Govindacharya, Yashodhar, Ramchandra, Somadava, Gopalbhatta etc. Indian Chemist of 19th century- Aacharya Prafulla Chandra Ray- His Contribution and work for Indian Chemistry.<br>**B. Atomic Structure and Periodic Properties:** (i) Review of Bohr's theory and its limitations. Dual nature of particles and waves, de Broglie's equation, Heisenberg's Uncertainty principle and its significance. (ii) Quantum numbers and their significance. Rules for filling electrons in various orbitals, Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau principle and its limitations, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals. Anomalous electronic configurations. (iii)Effective nuclear charge (ENC), shielding or screening effect, Slater rules, Atomic and Ionic radii. Ionization energy and factors affecting ionization energy. Electron affinity, Electronegativity—Pauling's/Mulliken's electronegativity scales. Relation of electronegativity with hybridization. | 11 |
| II | **Chemical Bonding – I A) Ionic Bonding:** General characteristics of ionic bonding.<br>**Ionic Bonding & Energy:** Lattice and solvation energies and their importance in the context of stability and solubility of ionic compounds.<br>**Born-Haber Cycle and its Applications:** Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules.<br>**B) Covalent Bonding:** Lewis structures, Valence Bond theory, Hybridization (concept and types with suitable examples), dipole moment and percentage ionic character. Valence shell electron pair repulsion theory (VSEPR) and structure of $NH_3$, $H_2O$, $SF_4$, $ClF_3$, $PCl_5$, $SF_6$, $XeF_2$, $XeF_6$, $XeO_3$, $XeOF_4$, $XeF_4$. | 12 |

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|---|---|---|
| | **Chemical Bonding - II**<br>**A) MO theory:** LCAO method-criteria of orbital overlapping, types of molecular orbitals-σ-, π- and, δ-MOs; formation of σ- and π-MOs and their, schematic illustration; qualitative MO energy level diagram of homo- ($N_2$ & $O_2$(including peroxide, superoxide) ) and hetero-diatomic molecules (NO, CO), magnetic properties, bond order and stability of molecules and ions.<br>**B)** Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, ion-induced dipole interactions, dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment). | |
| **III** | **A. Chemical properties of s-block metals**<br>Reaction with water, air, and nitrogen, Anomalous behavior of Li and Be, Compounds of s-block metals: Oxides, hydroxides, peroxides, and superoxides (preparation and properties)<br>Complexes of s-block metals, Complexes with crown ethers<br>**B. Chemistry of p-Block Elements**<br>**Boron group:** Hydrides (classification of boranes), Diborane (preparation, properties, and structure elucidation), Borazine (preparation and structure)<br>**Carbon group:** Carbides (salt-like carbides, interstitial carbides, covalent carbides), Silicates (classification, three-dimensional silicates - properties and structures)<br>**Nitrogen group:** Hydrides of Nitrogen (hydrazine, hydroxylamine, hydrazoic acid)<br>Structure of oxides of nitrogen ($N_2O$, NO, $NO_2$, $N_2O_4$, and $N_2O_5$), Structure of oxyacids of nitrogen ($HNO_2$, $HNO_3$, $H_2N_2O_7$,), Nitrides (classification, preparation, properties, and uses)<br>Structure of Oxides and oxoacids of phosphorus: ($P_2O_3$, $P_2O_5$) $H_3PO_2$, $H_3PO_3$, $H_3PO_4$, $H_4P_2O_7$<br>**Halogen:** Hydrides, Oxides and oxyacids of halogens (structure only) – Inter halogen compounds and pseudo halogens | **11** |
| **IV** | **Electronic Effects in Organic Compounds**<br>Bond Cleavage: Homolytic and heterolytic cleavages, bond energy, bond length, and bond angle. Electron Displacement Effects: Inductive, inductomeric, electromeric, mesomeric (resonance), hyperconjugation, and steric effects. Tautomerism (keto-enol, amido-imidol, and nitro-acinitro forms). Reaction Intermediates: Formation and stability of carbocations, carbanions, free radicals, carbenes, nitrene and benzyne.<br>**B. Stereochemistry of Organic Compounds**<br>**i) Optical Isomerism**<br>Elements of symmetry, chirality, enantiomers, and optical activity, Chiral and achiral molecules with two stereogenic centers (Tartaric acid as an example),Erythro & Threo, Diastereomers and meso compounds, Inversion, retention, and racemization, Relative configuration (D/L), and absolute configuration (R/S nomenclature: sequence rules).<br>**ii) Geometrical Isomerism**<br>Geometric isomerism (cis-trans isomerism) in alkenes with examples (maleic acid, fumaric acid, and 2-butene), E/Z system of nomenclature. | **11** |
| *Keywords* | ***Ancient Indian Chemistry, Atomic Structure, Periodic Properties, Chemical Bonding, s- &p-block elements, Electronic effects, Stereochemistry*** | |

***Signature of Convener & Members (CBoS) :***

## PART–C: Learning Resources

**Text Books, Reference Books and Others**

***Text Books Recommended –***
***Text Books***


1. Puri, B. R., Sharma, L. R., & Kalia, K. C. (2018). *Principles of Inorganic Chemistry*. Nagin Chand and Co., New Delhi.
2. Satyaprakash, G., Tuli, S. K., Basu, S. K., & Madan, R. D. (2017). *Advanced Inorganic Chemistry* (Vol. 1, 5th Ed.). S. Chand & Company.
3. Lee, J. D. (2010). *Concise Inorganic Chemistry* (5th Ed.). Blackwell Science.
4. Housecroft, C. E., & Sharpe, A. G. (2012). *Inorganic Chemistry* (4th Ed.). Pearson Education Limited.
5. Ray, Acharya Prafulla Charndra, ***History of Chemistry in Ancient And Medieval India***, Chowkhamba Krishnadas Academy (Reprint 2004).


**Reference Books**


1. Cotton, F. A., Wilkinson, G., & Gaus, P. L. (2002). *Basic Inorganic Chemistry* (3rd Ed.). John Wiley & Sons.
2. Douglas, B. E., Mcdaniel, D. T., & Alexander, J. J. (1994). *Concepts and Models Of Inorganic Chemistry* (3rd Ed.). John Wiley & Sons.
3. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). *Inorganic Chemistry* (4th Ed.). Harpercollins College Publishers.
4. Shriver, D. F., Atkins, P. W., & Langford, C. H. (2010). *Inorganic Chemistry* (5th Ed.). W. H. Freeman And Company.
5. Moeller, T. (1990). *Inorganic Chemistry: A Modern Introduction*. Wiley.


**Online Resources–**

- https://bit.ly/3AyV3mZ
- https://nptel.ac.in/courses/104/104/104104101/
- https://nptel.ac.in/courses/104/103/104103019/
- https://nptel.ac.in/courses/104/101/104101090/
- https://nptel.ac.in/courses/104/105/104105103/

**Online Resources–**

- **e-Resources / e-books and e-learning portals**

## PART -D: Assessment and Evaluation

**Suggested Continuous Evaluation Methods:**

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|---|---|
| **Maximum Marks:** | **100 Marks** |
| **Continuous Internal Assessment (CIA):** | **30 Marks** |
| **End Semester Exam (ESE):** | **70 Marks** |

| | | |
|---|---|---|
| **Continuous Internal Assessment (CIA): (By Course Teacher)** | Internal Test / Quiz-(2): **20**<br>Assignment / Seminar - **10**<br>Total Marks - **30** | Better marks out of the two Test / Quiz + obtained marks in Assignment shall be considered against **30** Marks |
| **End Semester Exam (ESE):** | **Two section – A & B**<br>Section A: **Q1**. Objective – **10 x1= 10** Mark; **Q2**. Short answer type- **5x4 =20 Marks**<br>Section B: Descriptive answer type qts.,**1out of 2** from each unit-**4x10=40 Marks** | |

***Name and Signature of Convener & Members of CBoS:***

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| **PART- A: Introduction** | | | | |
|---|---|---|---|---|
| **Program: Bachelor in Science** *(Certificate / Diploma / Degree/Honors)* | | | **Semester-I** | Session: **2024-2025** |
| 1 | **Course Code** | **CHSC-01P** | | |
| 2 | **Course Title** | **CHEMISTRY LAB. COURSE-I** | | |
| 3 | **Course Type** | **DSC** | | |
| 4 | **Pre-requisite** (if, any) | ***As per Program*** | | |
| 5 | **Course Learning. Outcomes (CLO)** | ➢ *Analyze mixtures for cations ($NH_4^+$, $Pb^{2+}$, etc.) & anions ($CO_3^{2-}$, $S^{2-}$, etc.) using $H_2S$ or other methods.*<br>➢ *Perform titrimetric analysis (standardization, unknown conc. determination).*<br>➢ *Estimate the concentration of acetic acid in vinegar (using NaOH), alkali content in antacids (using HCl), and free alkali in soaps/detergents.*<br>➢ *Utilize complexometric titrations for calcium ($Ca^{2+}$), water hardness, $Fe^{2+}/Fe^{3+}$, and $Cu^{2+}$.* | | |
| 6 | **Credit Value** | **1 Credits** | *Credit =30 Hours Laboratory or Field learning/Training* | |
| 7 | **Total Marks** | **Max. Marks: 50** | | **Min Passing Marks: 20** |

| **PART -B: Content of the Course** | | |
|---|---|---|
| **Total No. of learning-Training/performance Periods: 30 Periods (30 Hours)** | | |
| **Module** | **Topics (Course contents)** | **No. of Period** |
| **Lab./Field Training/ Experiment Contents of Course** | **QUALITATIVE INORGANIC MIXTURE ANALYSIS:** Inorganic mixture analysis containing up to four ionic species (two cations and two anions) using $H_2S$ (hydrogen sulfide) or other appropriate methods (Excluded are interfering and insoluble salts)<br>Cations and anions that may be encountered include:<br>**Cations:** $NH_4^+$, $Pb^{2+}$, $Bi^{3+}$, $Cu^{2+}$, $Cd^{2+}$, $Fe^{2+}/Fe^{3+}$, $Al^{3+}$, $Co^{2+}$, $Ni^{2+}$, $Mn^{2+}$, $Zn^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$, $Na^+$<br>**Anions:** $CO_3^{2-}$, $S^{2-}$, $SO_4^{2-}$, $NO_3^-$, $CH_3COO^-$, $Cl^-$, $Br^-$, $I^-$, $NO_2^-$, $SO_3^{2-}$<br>(Spot tests may be used wherever feasible.)<br>**TITRIMETRIC ANALYSIS**<br>Standardize sodium hydroxide solution using a standard oxalic acid solution.<br>Determine the concentration of hydrochloric acid (HCl) solution using standardized sodium hydroxide solution as an intermediate. | **30** |
| *Keywords* | *Qualitative Analysis ($H_2S$ method, Cations ($NH_4^+$, $Pb^{2+}$, etc.), Anions ($CO_3^{2-}$, $S^{2-}$, etc.), Titrimetric Analysis, Standardization (NaOH solution), Concentration Determination (HCl solution)* | |

***Signature of Convener & Members (CBoS) :***

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## PART–C: Learning Resources

**Text Books, Reference Books and Others**

**Textbooks Recommended:**


1. Gurtu, J. N., & Kapoor, R. (1987). *Experimental Chemistry*. S. Chand & Co.
2. Bajpai, D. N., Pandey, O. P., & Giri, S. (2013). *Practical Chemistry*. S. Chand & Co.
3. Ahluwalia, V. K., Dhingra, S., & Dhingram, S. (2005). *College Practical Chemistry*. Universities Press.
4. Kamboj, P. C. (2014). *Advanced University Practical Chemistry* (Part I). Vishal Publishing Co.
5. Fultariya, C., & Harsora, J. (2017). *Volumetric Analysis: Concepts and Experiments*.


**Reference Books Recommended:**


1. Mcpherson, P. A. (2015). *Practical Volumetric Analysis*. Royal Society Of Chemistry.
2. Shobha, R., & Banani, M. (2017). *Essentials of Analytical Chemistry*. Pearson.
3. Venkateswaran, V., Veeraswamy, R., & Kulandaivelu, A. R. (2004). *Basic Principles Of Practical Chemistry* (2nd Ed.). S. Chand Publications.
4. Sundaram, S., & Raghavan, K. (1996). *Practical Chemistry*. S. Viswanathan Co. Pvt.
5. Svehla, G. (2011). *Vogel's Textbook of Inorganic Qualitative Analysis* (7th Ed.). Pearson Education


**Online Resources–**

- https://bit.ly/3B7tOQV
- https://bit.ly/30V85ze
- https://bit.ly/3B5WOIQ
- https://bit.ly/3C9PXPS
- https://bit.ly/30Ip9rZ
- https://bit.ly/3BPnwqc

**Online Resources–**

- **e-Resources / e-books and e-learning portals**

## PART -D: Assessment and Evaluation

**Suggested Continuous Evaluation Methods:**

| | |
|---|---|
| **Maximum Marks:** | **50 Marks** |
| **Continuous Internal Assessment (CIA):** | **15 Marks** |
| **End Semester Exam (ESE):** | **35 Marks** |

| | | |
|---|---|---|
| **Continuous Internal Assessment (CIA):** **(By Course Teacher)** | Internal Test / Quiz-(2): **10 & 10**<br>Assignment/Seminar +Attendance - **05**<br>Total Marks - **15** | Better marks out of the two Test / Quiz + obtained marks in Assignment shall be considered against **15** Marks |
| **End Semester Exam (ESE):** | **Laboratory / Field Skill Performance: On spot Assessment**<br>**A. Performed the Task based on lab. work - 20 Marks**<br>**B. Spotting based on tools & technology (written) – 10 Marks**<br>**C. Viva-voce (based on principle/technology) - 05 Marks** | **Managed by Course teacher as per lab. status** |

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