

Syllabus for the post of Assistant Professor

Chemistry

S. No.	Paper	Question Format	Full Marks	Number of Questions	Exam Time
1	Paper I	Aptitude + Core Course (Objective)	50 + 50	100	100 Min.
2	Paper II	Core Course, Research and Teaching Learning (Subjective)	100	100	3 hrs.
Total written exam full marks			200		

Paper I

Aptitude Test (Objective)

Marks: $1 \times 50 = 50$

S. No.	Area of Questions Aptitude Test	Number of Questions	Details
1	Teaching and Communication Aptitude	15	Objectives and perspectives higher essential Qualities for higher education, Teaching Rolls: Individual, Social and Professional, Teaching methods, student evaluations and assessment
2	Research Aptitude Publication Ethics and Data Interpretation	15	Definitions and Importance of Research Objective Types and methods of Research, Research and Publication ethics, Data sources, Accessibility, Availability and presentation, Research based Articles, Journal quality, Project Work, Dissertation / Thesis Framework
3	Information and Communication Technology	10	Benefits and Risk, use of ICT in teaching learning and research virtual learning platforms, Digital education Resources Tools and Application
4	Higher Education system, Tribhuvan University	10	Higher education policy 2076, Tribhuvan University acts, laws and Bylaws

Paper I**Core Course (Objective)****Marks: 1 × 50 = 50**

Unit	Area of Questions	Number of Questions
1	Electrochemistry and Buffer Solution	5
2	Nuclear Chemistry	3
3	Environmental and green Chemistry for Clean technology	5
4	Catalysis and Catalyst and Photochemistry	4
5	Nanomaterial and nanotechnology	3
6	Co-ordination complexes	5
7	Organometallic compound and Interhalogen Compounds	3
8	Non aqueous solvent and elementary study of carbonyls and nitrosyls	3
9	Engineering Polymers, Microplastics	5
10	Instrumental techniques in Chemical Analysis	5
11	Reaction Mechanism	4
12	Biomolecules (Carbohydrate) and Heterocyclic Compounds	3
13	Research Methodology	2

Paper II**Core Course (Subjective)****Marks: 10 × 10 = 100**

S. No	Unit	Area of Questions	No of Questions
1	1 & 2	Electrochemistry and Buffer Solution, Nuclear Chemistry	2
2	3	Environmental and green Chemistry for Clean technology;	
3	4 & 5	Catalysis and Catalyst and Photochemistry; Nanomaterial and nanotechnology;	1
4	6, 7 & 8	Co-ordination complexes; Organometallic compound and Interhalogen Compounds; Non aqueous solvent and elementary study of carbonyls and nitrosyls	2
5			
6	9	Engineering Polymers	3
7	10	Instrumental techniques in Chemical Analysis	
8	11 & 12	Reaction Mechanism; Biomolecules (Carbohydrate) and Heterocyclic Compounds:	
9	13	Research methodology	1
10		Application, Problem Solving Teaching learning and evaluation Syllabus Structure	1

Syllabus for the post of Assistant Professor

Chemistry

1. Electrochemistry and Buffer Solution:

Introduction, Construction of galvanic cell, Nernst equation and its derivation and numerical, polarization and over potential, Buffer-Volmer equation and Tafel plots applications, Thermodynamics of electrified interface, Structure of double layer at metal electrolyte interface, semiconductor electrodes photo effects at semiconductor electrode, Industrial and applied electrochemistry: Batteries, primary and secondary batteries, Lead acid battery, Lithium – ion battery, Solar – photovoltaic cell: Types of photovoltaic cells, photo electro synthetic cells, photo catalytic cells, Fuel cells: Hydrogen fuel cell corrosion and its control: Introduction, cause of corrosion, consequences of corrosion, theories of corrosion: Dry corrosion and Wet corrosion, Types of corrosion, Factors affecting corrosion, protection against corrosion, applications of electroplating Buffer Solution: Introduction, buffer capacity, Practical Application of buffer solution, Types of buffer solution, mechanism of buffer actions, Henderson equation and related numerical.

2. Nuclear Chemistry:

Radioactivity, properties of radiations, types of radioactive decay, radioactive disintegration series, Rate of radioactivity decay, The activity of a radioactive substance, Nuclear reactions, Energy released in nuclear reactions, Atomic and Hydrogen Bomb.

3. Environmental and green Chemistry for Clean technology:

3.1 Environmental Chemistry: Reactions in the atmosphere:

Reactions involving oxides of nitrogen, oxidation of Sulphur dioxide, oxidation of organic compounds, greenhouse effect, Formation and depletion of ozone in the stratosphere air pollution, air pollutions and their effects on man and in environment, control of air pollution, water pollution and control, DO, BOD and COD, Pollution due to some typical industries sources and their remedies, Soil pollution, Hazardous waste and treatment technologies.

3.2 Green chemistry:

Introduction to green chemistry, Goals and significances of green chemistry, basic components of green chemistry research, Industrial applications of green chemistry.

4. Catalysis and Catalyst and Photochemistry:

4.1 Introduction positive and negative catalyst, Types of catalysis:

Homogeneous and heterogeneous catalyst, Selection criteria of catalyst

4.2 Photo catalysis:

Principle involved in photo catalysis, Dye degradation photocatalytic water splitting, application of catalyst in different fields.

4.3 Photochemistry:

Introduction, Photochemical reactions, Mechanism of some photochemical reactions, Applications of photochemistry in technology.

5. Nanomaterial and nanotechnology:

Introduction, Types of nanomaterials: OD, ID, 2D and 3D. Important nanostructure and their characteristics and applications, Nanotechnology: top – down and bottom – up processes, Ball milling, Exfoliation, Hummer method, physical vapour deposition, chemical vapour deposition and other methods.

6. Co-ordination complexes:

Classification of ligands, Chelation, Importance of chelates, chelates in analytical chemistry, Stereochemistry of complexes, valence bond theory: Formation of tetrahedral, square planar and octahedral complexes, crystal field theory (CFT): Important features of CFT, crystal field splitting of d orbitals of octahedral, tetrahedral and square planar complexes, distribution of d electron in t_{2g} and e_g orbitals, stability of complexes, crystal field stabilization energy, Factors affecting magnitude of Δ values, spectrochemical series, High spin and low spin complexes, colour of transition metal complexes, magnetic properties of complexes, Jahn Teller effects, Limitation of CFT.

7. Organometallic compound and Interhalogen Compounds:

Introduction, synthetic methods: metal alkyl group I, II and III, organometallic compounds of transition metals, σ and π bonded organometallic compounds, alkene, alkyne, allyl complexes, Application of organometallic compounds in the synthesis of organic compounds, Interhalogen compounds: Definition, Types, Preparation of differ types of Interhalogen compounds, structure of ClF_3 , ClF_5 , IF_6 and IF_7 on the basis of hybridization.

8. Non aqueous solvent and elementary study of carbonyls and nitrosyls:

Properties of ionic solvent, liquid ammonia and liquid Sulphur dioxide as a solvent, metal carbonyl: Classification of metal carbonyl, general methods of preparation, bonding in metal carbonyl, EAN rule applied to metal carbonyls, 18 electron rule, metal nitrosyl: bonding in nitrosyl.

9. Engineering Polymers:

Classification of Polymer in different ways: Natural and synthetic polymers organic and inorganic polymers, conductive and nonconductive polymers, thermoplastic and

thermosetting polymers, Fibers and elastomers, Types of polymerization, Free radical polymerization, condensation or step growth polymerization, Addition polymerization, Chemistry of some important organic polymer: Polycrylonitrile (PAN), Polymethylmethacrylate (PMMA), Polyaniline (PANI), Polypyrrole (PPY), Fiber reinforced polymer, epoxy resin, Cellulose, Chitin, Chitosan and Collagen.

Inorganic polymer:

Definition, properties of inorganic polymer, phosphorus based polymer, Preparation of polyphosphazene, Polyphosphonitrile Chloride, Polydimethoxy polyphosphazene and polydiethoxypolyphosphazene and their applications in engineering field, Sulphur based polymer: Preparation and applications of polythiazyl, Chalcogenide glass: Preparation and application of Chalcogenide glass, Silicon based polymer: Preparation and application of silicone, microplastics.

10. Instrumental techniques in Chemical Analysis:

Chromatography: Introduction, Thin layer Chromatography (TLC), Principle, instrumentation and applications, Gas Chromatography: Principle, instrumentation and applications High pressure liquid Chromatography: Principle instrumentation and applications

Spectroscopy: Introduction, Principle of Spectroscopy, Ultraviolet – visible spectroscopy (UV-Visible spectroscopy): Electronic transitions, types of electronic transition, chromophores and Auxochromes Absorption and intensity, Shift Solvent effect, Ultra violet spectra of some organic compounds.

Infrared Spectroscopy (IR Spectroscopy): Principle, absorption of Infrared spectrum, applications of IR Spectroscopy, Mass Spectroscopy: Principle, instrumentation and applications, Mass spectra of some simple compounds, Nuclear Magnetic Resonance Spectroscopy (NMR): Magnetic properties of nuclei, theory of NMR, Chemical shift, Factors influencing the Chemical shift, number of signals, peak area and proton counting, Splitting of signals, spin – spin coupling, NMR spectra of simple compounds, X-ray diffraction: Principle and applications, Bragg's law

11. Reaction Mechanism:

Types of organic reactions, Substitution reaction: Nucleophilic substitution reaction Detail mechanism of S_N1 and S_N2 reactions and stereochemistry, Elimination reaction: E_1 and E_2 reactions, addition reactions and rearrangements reactions.

12. Biomolecules (Carbohydrate) and Heterocyclic Compounds:

Biomolecules (Carbohydrate): General classification, Mutarotation, Glucose: structure of glucose, structure of fructose, Killani-Fischer synthesis, Ruff Degradation, Reducing Sugars, Non-reducing Sugars

Heterocyclic Compounds: Classification, Structure and basicity of 5-membered heterocycles (Pyrrole, Furan, Thiophene), Structure and basicity of 5 membered heterocycle (Pyridine)

13. Research Methodology

13.1 Fundamentals of Chemical Research

- Definition and Types: Scientific research, descriptive vs. analytical, fundamental vs. applied, and quantitative vs. qualitative methods.
- Problem Formulation: Identifying a research topic, defining the problem, hypothesis formulation, and developing a research design (experimental vs. theoretical).
- Ethical Issues: Intellectual property rights, plagiarism, copyright, data security, and reproducibility.

13.2 Data Analysis and Statistical Methods

- Errors in Chemical Analysis: Classification of errors (systematic, random), accuracy, and precision.
- Statistical Tools: Mean, standard deviation, significant figures, and confidence intervals.
- Hypothesis Testing:

13.3 Experimental Design and Techniques

- Instrumentation: Basic understanding of techniques like Chromatography (HPLC, GC, TLC), Spectroscopy (UV-Vis, IR, NMR, Mass Spec), and Microscopy (SEM, TEM).
- Safety and Chemical Handling: Proper handling of chemicals, waste management, and safety protocols.

13.4 Scientific Reporting and Communication

- Writing Skills: Structuring a thesis/dissertation, writing research papers, and technical reports.
- Format: Title, abstract, introduction, experimental, results, discussion, and references.
- Presentation: Creating effective figures, tables, and oral presentations.
- Proposal Writing.