Syllabus for the Position of Assistant Instructor

(*Chemistry***)**

S.N.	Paper	Question Format	Full Marks	Number of Questions	Exam Time
1.	**Paper I**	Aptitude Test + Core Course (Objective)	20 + 30	50	50 minutes
2.	**Paper II**	Core Course	100	10	3hrs
Total Written Exam Full Marks:			**150**		

Detail Syllabus

A. Aptitude Test

1. **Teaching Aptitude**

   Objectives of teaching leaning activities, teaching learning methods, requirement for good teaching learning Activity, Evaluation of students

2. **Communication Aptitude:** Related to classroom teaching and demonstration and management
3. **Professional Ethics, Data Collection, Analysis, Interpretation and Management:** Ethics related to laboratory instructor, sources of data and management of laboratory
4. **People, Society and Environment:** About geography of Nepal, population structure, cast, culture, natural resources, potential uses, climate change, constitution and higher education

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B. Core Course

1. Laboratory Safety and Management

1.1. General safety, CPR, fire extinguishers, safety routes, safety awareness and training, first aid and reporting and recording incidents and regular activities, resources and management

1.2. Safety in chemistry laboratory, use of material safety data (MSDS) sheet, and personal protection equipment (PPEs) used in chemical laboratory

1.3. Storage of chemicals, handling of chemicals, management of chemicals, reagents and equipment

1.4. Laboratory hazards, fire and heat hazards, electric shock, burning, glassware hazards, VOCs, list of corrosives, toxic, explosives, volatile, hazardous chemicals and safety measures, hazards due to nanomaterials

1.5. Laboratory waste management, organic solvents, acids, alkalis, glassware, metals, e-waste, solid waste

2. Laboratory Techniques and Instrumentation

2.1. Preparation of solutions of solids, liquids, volatile, non-volatile, substances, preparation of standard & primary standard solutions, dilution.

2.2. Qualitative and quantitative analysis, volumetric analysis, titration, acidimetry, alkalimetry, complexometric titration, iodometric titration, iodimetric titration, redox titration, permanganometric titration, gravimetric analysis

2.3. Salt analysis, dry test, wet test, test for basic radicals, test for acid radical

2.4. Preparation of complexes, Ni-DMG

2.5. Chemical kinetics, oxidation of iodine by using persulphate solution, iodine clock method,

2.6. Water analysis, hardness, alkalinity of water by titration

2.7. Detection of elements, identification of functional groups and compounds, preparation of organic compounds, Aniline, benzanilide, β-Naphthol, salicylic acid, aspirin, osazone, determination of melting and boiling points, test for carbohydrates

2.8. Extraction of essential oils from natural sources

2.9. Separation of mixtures, chromatography, distillation, purity test

2.10. Instrumentation, viscometer, stalagmometer, AAS, centrifuge, UV-vis spectrophotometer, pH meter, XRD, lyophilizer, oven, purification, heating and drying instrument

3. General and Physical Chemistry

3.1. Basic concept of chemistry, atoms, ions, molecules, mixture, separation techniques

3.2. **States of mater: Solid**: Crystalline and amorphous substances, seven crystal system and fourteen Bravais lattice system, hygroscopic, efflorescence and deliquescent, **Liquid:** General properties of liquid, evaporation and boiling, surface tension and viscosity (with relevant numerical). **Gas states:** Postulates of kinetic gas theory, Gas laws (Boyles law, Charlse law, Dalton's law of partial pressure, Graham's law of diffusion), kinetic gas equation, ideal gas and real gas, deviation of ideal gas, compressibility factor, van der Waals' equation, compressibility factor, liquefaction of gas.

3.3. **Atomic structure:** Bohr's atomic model with postulates and limitations, Hund's rule, Pauli's exclusion principle, Aufbau principle, electronic configuration, quantum numbers.

3.4. **Chemical bonding:** Ionic bond, covalent bond and coordinate covalent bond, hydrogen bond, van der Waals' force, metallic bond, percentage ionic characters

3.5. **Oxidation-reduction:** Classical and electronic concept of oxidation and reduction, disproportion reaction, balancing the equation by ion-electron method. Oxidants, reductants, oxidation number range of elements.

3.6. **Chemical equilibrium:** Homogeneous and heterogeneous equilibrium, relation between kp and kc. Le-Chatelier's principle, its application in physical and chemical equilibrium. Related numerical.

3.7. **Ionic equilibrium:** Ionization constant, autoionization of water, pH an pOH, Ostwald' dilution, classification of salt, salt hydrolysis and related numerical, common ion effect and solubility product principle with related numerical, buffer solution with relevant numerical.

3.8. **Volumetric analysis:** Principle of volumetric analysis, concept of percentage concentration, gram per liter, normality, molarity, molality, formality, mol fraction, ppm and ppb, titration, types of titrations, choice of indicator, commonly used acid-base indicator in laboratory.

3.9. **Chemical kinetics:** Average and instantaneous rate of reaction, order and molecularity of reaction, unit of rate constant, unit of rate of reaction, zero, pseudo, first and second order reaction, half-life period calculation. Theories of reaction, concept of activation energy.

3.10. **Thermodynamics:** Zeroth, first, second and third law of thermodynamics, heat of reaction (heat of neutralization, heat of combustion, heat of formation, heat of hydration), bond energy, Hess law of constant heat summation, Gibbs free energy, spontaneity and criteria of spontaneity.

3.11. **Electrochemistry:** Faraday's first law and second law, Electrolytic cell and galvanic cell, calculation of cell emf, $\Delta G = -nFE$, different types of electrodes, attackable and non-attackable electrode, primary and reference electrode (calomel, silver-silver chloride, mercury oxide electrode, platinum electrode), salt bridge, Nernst equation with related numerical.

3.12. **Catalyst and catalysis:** Classification of catalyst, theory of catalyst, concept of catalytic poisoning, recent trends in the development of catalyst and nano catalyst.

4. Inorganic chemistry

4.1. Periodic Table, Modern periodic table, classification of elements, periodic properties, ionization energy, electron affinity, electronegativity, size

4.2. Metals, alloys, metallurgy, general principles

4.3. Heavy metals, common characteristics, applications, steel

4.4. Rare-earth metals, introduction, optoelectronic, magnetic and conductive properties and applications

4.5. Complexes, nomenclature, theories

4.6. Preparation of gases, O_2, H_2, NH_3, CO_2, H_2S, storage, handling and applications

5. Organic Chemistry

5.1. Fundamentals of organic chemistry, nomenclature, isomerism, reaction intermediate

5.2. Hydrocarbons, natural gas, petroleum oils, coals, CNG, LPG, chemical compositions, and applications, quality of fuel, cracking, reforming

5.3. Benzene, aromaticity, alkyl halides, S_N1 and S_N2, Alcohol, industrial sources and uses Ethers, phenols, carbonyl compounds, aldol condensation, tests, Carboxylic acids and derivatives, malonic ester synthesis, factors affecting acidity, Nitro & amines compounds, basic nature, diazotization, uses

5.4. Carbohydrates, classification, monosaccharides, disaccharides, polysaccharides, proteins, introduction, amino acids, isoelectric point, peptides and proteins, structure, types, amino acid preparation, lipids, fats and oils, micelle, saponification, detergents

5.5. Polymers, natural and synthetic, cellulose, chitosan, rubber, nylon, polyacrylonitrile, PVC, polycarbonates, Teflon, polypropylene, polyethylene terephthalate (PET), Bakelite, polymers in biomedicals, polymerization, conductive polymers, dyes and drugs

5.6. Heterocyclic compounds, structure, properties and applications

5.7. Mass, IR, NMR spectroscopy, principles and interpretation

6. Sustainable and Nanochemistry

6.1. Water analysis, different parameters, hardness of water, heavy metal ions as pollutant, upper permissible level of heavy metals in drinking water as per WHO, significance of hard water, removal of hardness of water, COD, BOD, water pollutants, microplastics, air pollution, PM, smog, gaseous pollutants, greenhouse effect, municipal waste management

6.2. Green chemistry principles

6.3. Corrosion, general introduction and types

6.4. Concept of nanochemistry, general introduction and types of nanomaterials and applications

7. TU Laws 2049, TU Teacher and Officers Service laws (2050) (Section 5, 6,9, and 10), TU Economic Management and Procurement laws (2050) (Section 12, 13 and 14)

8. General ICT Knowledge and Recent Trends, Nepal Constitution (Section 2, 3,7,8,9,11,13,14,17,18 and 20)

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Paper I: Objective (Aptitude Test + Core Course) Marks: 1 × 50 = 50

Unit	Area of Questions	Number Questions
	Aptitude test	
1	Teaching Aptitude	5
2	Communication Aptitude	5
3	Professional Ethics, Data Collection, Analysis, Interpretation and Management	5
4	People, Society and Environment	5
	Core Course	
1	Laboratory Safety and Management	3
2	Laboratory Techniques and Instrumentation	3
3	General and Physical Chemistry	4
4	Inorganic Chemistry	4
5	Organic Chemistry	4

6	Sustainable and Nanochemistry	2
7.	TU Laws 2049, TU Teacher and Officers Service laws (2050) (Section 5, 6,9, and 10), TU Economic Management and Procurement laws (2050) (Section 12, 13 and 14)	5
8.	General ICT Knowledge and Recent Trends, Nepal Constitution (Section 2, 3,7,8,9,11,13,14,17,18 and 20)	5

In core course multiple choice questions (MCQs), about 60-65% Knowledge and Comprehension/ Understanding type, about 30-35% Application type, and about 10-15% Analysis, synthesis and Evaluation type questions will be asked.

Paper II: Core Course Marks: 10 × 10 = 100

Subjective Knowledge

S.N.	Unit	Area of Questions	No of Questions
1.	1	Laboratory Safety and Management	1 × 10 = 10 Marks
2.	2	Laboratory Techniques and Instrumentation	2 × 10 = 20 Marks
3.	3	General and Physical Chemistry	2 × 10 = 20 Marks
4.	4	Inorganic Chemistry	1 × 10 = 10 Marks
5.	5	Organic Chemistry	2 × 10 = 20 Marks
6.	6	Sustainable and Nanochemistry	1 × 10 = 10 Marks
7.		TU Laws 2049, TU Teacher and Officers Service laws (2050) (Section 5,6,9, and 10), TU Economic Management and Procurement laws (2050) (Section 12, 13 and 14)	1 × 10 = 10 Marks

In subjective Knowledge questions, each 10 marks question may be subdivided into two subdivision a and b.

द्रष्टव्य :

1. लिखित परीक्षाको लागि १०० पूर्णाङ्कको एक पत्र हुनेछ ।

2. वस्तुगत बहुवैकल्पिक (Multiple Choice) प्रश्नको विकल्प छनौट गर्दा गलत विकल्प छानेमा ऋणात्मक मूल्याङ्कन (Negative Marking) गरिने छ । अर्थात् यसरी मूल्याङ्कन गर्दा प्रत्येक गलत उत्तरको लागि २० प्रतिशत अङ्ककट्टा गरिनेछ । बहुबैकल्पिक प्रश्नको २० प्रतिशत अङ्क प्राप्ताङ्कबाट घटाइने छ । (उदाहरणका लागि परीक्षार्थीले २० अङ्कको बहुवैकल्पिक प्रश्नमा १५ प्रश्नको सही उत्तर र ५ प्रश्नको गलत उत्तर दिएमा निजको प्राप्ताङ्क (०.२० × ५=१.००) अर्थात् १५–१= १४ अङ्क हुनेछ । तर उत्तर नदिएमा त्यस बापत अङ्क दिइने छैन र अङ्क कट्टा पनि गरिने छैन ।

3. विषयगत प्रश्नको हकमा एउटै प्रश्नका दुई वा दुई भन्दा बढी भाग (Two or more parts of a single question) वा एउटा प्रश्न अन्तर्गत दुई वा बढी टिप्पणीहरू (Short notes) सोध्न सकिने छ ।

4. प्रत्येक पत्रको उत्तीर्णाङ्क पूर्णाङ्कको ४० प्रतिशत हुनेछ ।

5. भाषा विषयबाहेक अन्य विषयका लागि उत्तरको माध्यम अंग्रेजी वा नेपाली हुनेछ ।