Engineering Chemistry-I
EG 1105 SH

Year: I **Total: 8 hours /week**
Semester: I **Lecture: 4 hour/week**
Tutorial: 2 hours/week
Practical: hours/week
Lab: 2 hours/week

Course Description:
This subject consists of three units related to language of chemistry, general chemistry and system of classification.

Course Objectives:
After the completion of this subject, students will be able to

- Develop a basic knowledge and concept of chemical reactions.
- Solve simple numerical problems related on atomic weight, molecular weight, mole concept.
- Explain the different theories of acid and base and to know the concept of pH and buffer solution.
- Know about atomic structure, periodic table and chemical bonding.
- Prepare different concentration of solution and solve simple numerical problem.
- Describe the laws of electrolysis and solve related numerical problems.
- Explain the basic concept of Chemistry relevant to problems for the understanding and practicing related in engineering works.

Course Content

Unit 1: Language of Chemistry **[8 Hrs.]**

1.1. Symbol **[1 Hr.]**

- Introduction
- Definition
- Name and symbol of elements up to atomic number 30
- Concept of symbol which were derived from Latin or other languages such as Potassium, sodium, iron, copper, gold, lead, mercury, silver, and tin etc.
- Significances of symbol (qualitative and quantitative)

1.2. Formula, valency and radicals **[2 Hrs.]**

- Introduction
- Definition of molecular formula & Structural formula
- Qualitative and quantitative significances of molecular formula
- Concept of valency in terms of combining capacity with H2, O2 and Cl2
- Variable valency (ref Fe, Sn, Cu, Pb, Hg, S, N)
- Radicals
  - classify the radicals as electro- positive and electro – negative with examples
  - concept of simple, compound and complex radicals
- Methods of writing the molecular formula

1.3. Chemical equation **[5 Hrs.]**

- Introduction
- Essentials of chemical equation

- Significance of chemical equation (qualitative and quantitative)
- Limitation of chemical equation
- Making the chemical equation more informative
- Balancing chemical equation by
  - hit and trial method
  - partial equation method (ref. reaction involving HNO_3, MnO_2, $KMnO_4$, $K_2Cr_2O_7$ etc.)
- Types of chemical reaction:
  - combination, decomposition, displacement, double displacement, acid base, hydrolysis, polymerization
- Conditions of bringing about chemical reactions

Unit 2: General Chemistry **[16 Hrs.]**

2.1. Atom and molecule **[2 Hrs.]**

- Definition
- Postulates of Dalton's atomic theory
- Modern position of the theory
- Limitations of Dalton's atomic theory

2.2. Atomic weight **[4 Hrs.]**

- Introduction
- Definition
- Atomic weight of an element
- Atomic mass unit
- Gram atomic mass unit
- Concept of fractional atomic mass unit (ref giving example of chlorine)
- Dulong and Petit's method and its limitations
- Steps involved for the determination of atomic weight by Dulong and petit's method
- Solving related simple numerical problems

2.3. Molecular weight **[4 Hrs.]**

- Introduction
- Definition of molecular weight of an elements or compounds
- Gram molecular weight
- Concept of Avogadro's hypothesis
- Application of Avogadro's hypothesis:
  - determination of atomicity of an elementary gas like H_2, Cl_2, O_2, and N_2
  - determination of relationship between molecular Weight & Vapour density
  - determination of gram molecular volume of all gases is equal to22.4 litres at NTP
  - determination of gram molecular weight of any gas contains same no of molecules
- Avogadro's number
- Determination of molecular weight by Victor Meyer's method
- Solving related simple numerical problems

2.4. Equivalent weight **[4 Hrs.]**

- Introduction
- Definition of equivalent weight of element, acid, base and salt
- Gram equivalent weight
- Relation between equivalent weight, atomic weight and valency

- Determination of equivalent weight of metals by
  - by hydrogen displacement method
  - by direct and indirect oxide method
- Solving related simple numerical problems

2.5. Simple mole concept [2 Hrs.]

- Introduction
- mole of an atom, mole of a molecule, molar volume
- Solving related simple numerical problems

Unit 3: System of Classification [36 Hrs.]

3.1. Acids, Bases and Salts [5 Hrs.]

- Introduction
- Characteristics of acid and base
- Arrhenius concept of acid and base and its limitations
- Lowry and Bronsted concept of acid and base and its limitations
- Conjugate acid and base pair
- Amphoteric nature of water
- Lewis concept of acid and base and its limitations
- Salt
- Types of salts (normal, acidic and basic)
- pH and POH and its mathematical expression
- pH scale
- prove that pH+ pOH=14
- Simple numerical problem on pH
- Buffer solution with examples and its types (No buffer mechanism is required)

3.2. Volumetric analysis [5 Hrs.]

- Introduction
- Titration, acidimetry and alkalimetry
- Indicator and their colour and selection of indicators in acidic and basic medium
- End point
- Standard solution, unknown solution, normal solution
- Preparation of normal solution, decimolar solution, molar solution
- Normality factor
- Different ways of expressing the concentration of solution:
  - normality, molarity, gram per litre and percentage
- Concept primary standard substance and secondary standard substances
- Primary standard solution and secondary standard solution
- Volumetric equation
- Solving related simple numerical problems

3.3. Electronic theory of valency [4 Hrs.]

- Introduction
- Valence electron and valence shell, core electron, inert gas
- Concept of lewis dot symbol
- Octet rule
- Basic assumptions of electronic theory of valency
- Chemical bond
- Types of chemical bond

- Definition of electrovalent bond (ionic bond), electrovalency and electrovalent compounds (ionic compound) and electrovalent compounds like NaCl, MgO, CaS, MgCl2 etc. with electron dot structure showing the formation of electrovalent compounds
- General properties of ionic compounds
- Definition of covalent bond, covalency and covalent compounds and covalent compounds H2, Cl2, O2, N2, CH4, H2O, NH3, CO2, CH4, C2H2 etc. with electrons dot structure showing the formation of covalent compounds
- General properties of covalent compounds
- Definition of coordinate covalent bond (dative bond), coordinate covalency and coordinate covalent compounds and coordinate covalent compounds like SO2, SO3, NH4+, H2SO4, NaNO3, CaCO3, Na2CO3, Na2SO4 etc. with electron dot structure to represent the formation of coordinate covalent compounds
- General properties of coordinate covalent compounds

3.4. Electrolysis [6 Hrs.]

- Introduction
- Definition
- Electrolytes
- Types of electrolytes:
  - weak and strong and non-electrolytes
- Faraday laws of electrolysis
- Faraday
- Relation between Faraday, chemical equivalent and electrochemical equivalent
- Application of electrolysis
- Solving related simple numerical problems
  - Corrosion
    - Types of corrosion (chemical corrosion, bio-corrosion, electrochemical corrosion)
    - Rusting of iron (no explanation required the theory of rusting)
    - Prevention of corrosion
  - Electrochemical series
    - Introduction
    - Applications of electrochemical series

3.5. Periodic table [4 Hrs.]

- Introduction
- Mendeleev's periodic table(law)
  - Main features of Mendeleev’s periodic table (Explanation of short and long periods, groups, sub groups, zero group, VIII group)
  - Advantages of Mendeleev’s periodic table (Systematic study of elements, prediction of new elements and correction of doubtful atomic weight)
  - Anomalies of Mendeleev’s periodic table (position of hydrogen, position of isotopes, position of anomalous pair of elements, position of lanthanides and actinides, separation of similar elements and grouping of dissimilar elements)
- Modern periodic table(law)
  - Advantages of Modern periodic table (Position of hydrogen, position of isotopes, position of anomalous pair of elements)

3.6. Oxidation and reduction [6 Hrs.]

- Introduction

- Classical and electronic concept of oxidation and reduction
- Classical and electronic concept of oxidizing agent (oxidant) e.g. O2, O3, halogens, HNO_3, MnO_2, $K_2Cr_2O_7$, $KMnO_4$ etc. and reducing agent (reductants)eg.H_2, HBr, HI, H_2S etc.
- Redox reaction (concept of split into oxidation half and reduction half)
- Oxidation and reduction go side by side
- Oxidation number
- General rule for assigning oxidation number
- Methods of calculation the oxidation number of an atom in a compound
- Oxidation and reduction in terms of oxidation number
- Auto-oxidation eg.H_2O_2, HNO_2, SO_2
- Balancing of simple chemical equation by oxidation number method

3.7. Atomic structure [6 Hrs.]

- Introduction
- Concept subatomic particles like electron, proton and neutron concerning their charge, mass and location in atom (no explanation of cathode ray experiment is required)
- Rutherford's α - rays scattering experiment and its observations
- Rutherford's atomic model and its drawbacks
- Postulates of Bohr's atomic model
- Atomic number and mass number
- Isotopes, isobars and isotones
- Bohr - Bury Scheme
- Aufbau principle
- Electronic Configuration of atoms (atomic number 1-30)
- Hund's rule of maximum multiplicity
- Quantum number and its types (principal, azimuthal, magnetic and spin)
- Pauli's exclusion principle

Tutorial

Unit 1: Practice on writing the significances of symbol, molecular formula, chemical equation, balancing of chemical equation by hit and trial and partial methods. [**4 Hrs.]**

Unit 2: Practice on application of Avogardo's hypothesis, relation between atomic weight, equivalent and valency, Solve numerical problem on atomic weight, molecular weight, equivalent weight and mole concept. **[8 Hrs.]**

Unit 3: Practice on different theories of acid, base, types of salt, pH and pOH value, preparation of different types of solution, Faradays laws of electrolysis, different types of chemical bond and their electron dot structure, Mendeleev's periodic table and modern periodic table, different concept of oxidation and reduction, balancing of chemical equation by oxidation number method, Rutherford's and Bohr's atomic model, electronic configuration of atoms, solve numerical problem on pH, volumetric analysis, electrolysis **[18 Hrs.]**

Evaluation Scheme

There will be questions covering all the chapters in the syllabus. The evaluation scheme for the questions will be as indicated as in the table below.

Unit	Chapter	Hours	Marks distribution
1	Symbol, formula, valency and radicals	3	4
	Chemical equation	5	4
2	Atom, molecule, Atomic weight	6	4
	Molecular weight	4	4
	Equivalent weight, mole concept	6	8
3	Acid, Base and salts	5	4
	Volumetric analysis	5	4
	Electronic theory of valency	4	4
	Electrolysis	6	4
	Periodic table	4	4
	Oxidation and reduction	6	8
	Atomic structure	6	8
	Total	**60**	**60**

Note: There may be minor deviation in marks distribution. Choice question can be asked from the same chapters.

Engineering Chemistry Practical I **[30hrs]**

1. Simple Glass Working [6hrs]
   a. cut the glass tube into three equal parts and round up their shape edges
   b. bore a hole through a cork
   c. bend the glass tubing into acute, obtuse and right angle
   d. draw a jet and capillary tube
   e. fit up a wash bottle
2. Neutralize dilute sulphuric acid with sodium hydroxide solution, and to recover crystals of sodium sulphate.
3. Obtain pure and dry precipitate of barium sulphate by treating dilute sulphuric acid with barium chloride solution. [2hrs]
4. Separate sand and copper sulphate crystals in pure and dry state from the mixture of sand and copper sulphate. [2hrs]
5. Separate sand and calcium carbonate in pure and dry state from the mixture of sand and calcium carbonate. [2hrs]
6. Prepare pure water from supplied impure water by distillation and to test the purity of the sample prepared. [2hrs]
7. Determine the equivalent weight of reactive metal by hydrogen displacement method. [2hrs]
8. Prepare primary standard solution of sodium carbonate and to use it to standardize an approximate decinormal acid solution. [2hrs]
9. Standardize given unknown acid (Approx N/10) solution by preparing standard alkali solution. (Expression of strength in different ways) [2hrs]
10. Standardize given unknown alkali (approximately N/10) solution with the help of by preparing standard acid solution. (Expression of strength in different ways) [2hrs]

11. Determine the pH of different unknown solution and using pH paper and universal indicator. [2hrs]
12. Investigate the composition of water by electrolysis by using Hofmann's apparatus. [2hrs]
13. Carry out conductivity experiments on solids and liquids ($CuSO_4$, Zn, Mg, Al, Fe, CCl_4, C_6H_6, C_2H_5OH) [2hrs]

Prescribed Books:

1. Foundations of Chemistry, Vol. 1, M.K. Sthapit and R.R. Pradhananga, Taleju Prakashan, Kathmandu
2. A Textbook of Engineering Chemistry, vol. I, Prakash Paudel, Siddthartha Publication, Kathmandu
3. Engineering Chemistry, Vol.1 M.L. Sharma, K. M. Shrestha, PN, Choudhary, Ekta Book, Kathmandu.
4. A Text book of Chemistry, Jha and Guglani, Surya publication, India
5. Fundamentals of Chemistry, K.R. Palak, Ratnapustak Bhandar, Kathmandu
6. Elementary Practical Chemistry, M.K. Sthpit, Taleju Prakashan, Kathmandu
7. Practical Engineering Chemistry for diploma level, Sumitri Bajracharya, Sabina Shrestha, Kathmandu Institute of Technology

Other Learning Materials:

1. Other references to be selected by the related lecturer(s) from among the texts available in the market that meet the content needs of this subject.
2. The related institute may develop its own textbook and approve from the related authority so as to have a prescribed textbook of this subject.