ENGINEERING CHEMISTRY

SH 153

Lecture : 3 **Year : I**
Tutorial : 1 **Part : II**
Practical : 3

Course Objectives:
To develop the basic concepts of physical chemistry, inorganic chemistry, analytical chemistry, environmental chemistry, green & sustainable chemistry, nano chemistry, polymer chemistry and organic chemistry relevant to the different disciplines of engineering.

1 Electrochemistry and Buffer (8 hours)

1.1 Electrochemistry
- 1.1.1 Introduction
- 1.1.2 EMF of galvanic cell, Nernst equation
- 1.1.3 Polarization and Overpotential
- 1.1.4 Butler-Volmer equation and Tafel plots

1.2 Electrode Processes and Mechanisms (qualitative only)
- 1.2.1 Charge transfer processes at electrodes
- 1.2.2 Mass transfer and diffusion in electrochemical systems

1.3 Industrial and applied electrochemistry
- 1.3.1 Batteries (Lead acid and lithium ion)
- 1.3.2 Solar-photovoltaic cell (with typical examples)

1.4 Buffer, Buffer range, Buffer capacity and Buffer solution (Henderson-Hasselbalch equation) and its applications

2 Catalyst and Catalysis (4 hours)

2.1 Catalyst: Definition and Types (homogeneous and heterogenous)

2.2 Catalyst: Design and Optimization
- 2.2.1 Structure-activity relationships
- 2.2.2 Selection criteria of catalyst

2.3 Photocatalysis and electrocatalysis

2.4 Catalysis for energy and environmental applications
- 2.4.1 Catalytic conversion of fossil fuels
- 2.4.2 Renewable energy catalysts
- 2.4.3 Catalyst for pollution control

3 Analytical Techniques and their Applications (6 hours)

3.1 Chromatography
3.2 Mass spectroscopy
3.3 X – ray diffraction (XRD)
3.4 UV – visible spectroscopy
3.5 Infrared – spectroscopy (IR)
3.6 Nuclear magnetic resonance spectroscopy (NMR)

4 Metal Complexes, Rare Earth Elements and Metal alloys (6 hours)

4.1 Complexes
  4.1.1 Introduction and Werner's theory
  4.1.2 Geometry of complex by VBT and its applications
  4.1.3 Crystal Field Theory: Principle and applications
4.2 Rare earth elements: Introduction and applications
4.3 Metallic alloys and applications

5 Sustainable Chemistry (7 hours)

5.1 Green chemistry: Introduction and principles
5.2 Water chemistry
  5.2.1 Importance of water quality standards
  5.2.2 Degree of hardness, scale formation in boiler and softening of hard water
  5.2.3 Water pollution with reference to turbidity, COD, BOD, heavy metals, radioactive substances, and plastic
  5.2.4 Industrial wastewater and its treatment
5.3 Air pollution
  5.3.1 Particulate matter, SOx, NOx, GHGs, VOCs, their impacts and remedies
5.4 Waste management
  5.4.1 Segregation and management of solid waste
  5.4.2 Management of biodegradable waste into energy
  5.4.3 E-waste and its management

6 Nanoscience and Nanotechnology (3 hours)

6.1 Introduction and types of nano materials (0-, 1-, 2-, and 3- dimensional)
6.2 Nanoparticles, Nanofibers, Nanowires, Carbon nanotubes, graphene, Mxene, quantum dots, and their uses
6.3 Preparation of nanomaterials

7 Engineering Materials (7 hours)

7.1 Polymers
- 7.1.1 Natural and synthetic, organic and inorganic, conducting and non-conducting
- 7.1.2 Types of polymerizations: Addition and condensation polymerization
- 7.1.3 Preparation and applications of – Epoxy resin, polyurethane, Kevlar, polycarbonate, polymethyl methacrylate, polyacrylonitrile, silicones; phosphorus based polymer, Sulphur based polymer
- 7.1.4 Conducting polymers: Synthesis and application
- 7.1.5 Composite: Fiber reinforced polymer
- 7.1.6 Natural polymers: cellulose, chitin, chitosan, collagen

7.2 Cement: Hydration and setting chemistry of cement

8 Explosives, Lubricants and Paints (4 hours)

8.1 Explosives
- 8.1.1 Types of explosives: Primary, low and high explosives
- 8.1.2 Preparation and applications of TNT, TNG, Nitrocellulose and Plastic explosives

8.2 Lubricants: Introduction, function and classification

8.3 Paints
- 8.3.1 Introduction, requisites, types and applications
- 8.3.2 Environmental and health impact

Tutorial

1. Introduction to cells, electroplating, EMF, Electric double layer, Problems related to buffer and Nernst equations (3 hours)
2. Types of catalyst and types of catalysis (1 hour)
3. Electromagnetic radiation, Electromagnetic spectrum, Electromagnetic wave, Principles of Spectroscopy, Types of Molecular Spectra (3 hours)
4. Complexes, ligands, postulates, compounds with coordination number 4 and 6,splitting of Octahedral and tetrahedral complexes and Rare earth elements (2 hours)
5. Application of Green Chemistry. Industrial waste management (2 hours)
6. Application of nanomaterials in pollution minimization (1 hour)
7. Introduction and stabilization of Free radicle, Carbocation and Carbanion. Exothermic reaction of cement and its applications (2 hours)
8. Introduction of and applications of explosives, lubricants and paints (1 hour)

Practical

1. Determine of total, temporary and permanent hardness of water sample using complexometric titration.
2. Determine the alkalinity of water sample A and B by double indicator titration.
3. Estimate the amount of residual chlorine in water by iodometric titration.

4. Prepare the standard buffer solution (acidic or basic) and measure the approximate pH of given unknown solution by using Universal Indicator.
5. Compare the cleansing power of two sample of detergents by determining the reduction they cause in surface tension of water.
6. Construct Daniell cell and study the variation of cell potential with concentration.
7. To separate the pigments through the process of paper / thin layer chromatography.
8. Determination of total iron in ground water using spectrophotometer technique.
9. Determination of amount of copper and iron in a given mixture solution by K2Cr2O7 titration.
10. To prepare Cross – linked polymer by condensation polymerization method.
11. Standardize Potassium Permanganate Solution and use it to estimate the amount of Iron and determine the Percentage purity in the sample of Ferrous salt Solution.
12. Prepare Ni-DMG Complex and to estimate the amount of Nickel in it.

Final Examination

Chapter	**Hours**	**Marks Distribution***
1	8	10
2	4	5
3	6	5
4	6	10
5	7	10
6	3	5
7	7	10
8	4	5
Total	45	60

*There may be minor deviation in mark distribution

References

1. S.H. Maron and C. Prutton, (1992). Principles of Physical Chemistry, 4th Edition, Oxford and IBH Pub. Co.
2. J.D. Lee, (2007). Concise Inorganic Chemistry, 5th Edition, John Wiley and sons, Inc.
3. R.D. Madan & Satya Prakash, (1994). Inorganic Chemistry, S. Chand & Company Ltd.
4. S. Bahl, G.D. Tuli & A. Bahl, (2009). Essential of Physical Chemistry, Revised Multicolor Edition, S. Chand & Co. Ltd., New Delhi.
5. A.K. Bhagi & G.R.T. Morrison & R.N. Boyd, (2008). Organic Chemistry, 6th and 7th Edition, Prentice – Hall of India Pvt. Ltd.
6. R.T. Morrison & R.N. Boyd, (2008). Organic Chemistry, 6th and 7th Edition, Prentice – Hall of India Pvt. Ltd.

7. J. Mendham, (2008). Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education.
8. B.S. Murthy, P. Shankar, Baldev R, B. B. Rath & James Murday, (2012.) Textbook of Nanoscience and Nanotechnology, Series in Metallurgy and Materials Science, Baldev Raj (Ed.), Universities Press Private Hyderabad, India, Chatwal, Environmental Chemistry, Himalaya Publishing House, Mumbai.