Bachelor of Sciences in Industrial Chemistry

Category II

Industrial Chemistry Course for Undergraduate Programme of study with Industrial Chemistry as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – 7: (DSC-7) Industrially important Inorganic Materials

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Industrially important Inorganic Materials (DSC-7: Industrial Chemistry -III)	04	02	0	02	Class XII Pass with Physics, Chemistry, Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To imparts basic knowledge of chemistry of inorganic materials such as silicates, non-silicates, ceramics, and cement.
- To enrich students with the knowledge of various types of batteries like Pb acid Battery, Li-ion Battery, Fuel Cells and Solar cell.
- To impart the theoretical and practical knowledge of estimation and determination of various industrially important chemicals.

Learning outcomes

By the end of this course, students will be able to:

- Establish an appreciation of the role of inorganic chemistry in the chemical sciences.
- Analyse inorganic materials like silicates, ceramics and cement.

- Familiarized with scientific method of planning, developing, conducting, reviewing and reporting experiments.
- Draw various concepts of industrial metallurgy which will help them to explore new innovative areas of research.
- Explain scientific methods employed in inorganic chemistry.

SYLLABUS OF DSC-7

Unit 1: Silicate Industries **14 Hours**

(a) *Glass*: Glassy state and its properties, Classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of the following: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, and photosensitive glass.
(b) *Ceramics*: Ceramic, their types and manufacture. High technology ceramics and their applications, super conducting and semiconducting oxides, fullerenes carbon nanotubes and carbon fiber, clays and feldspar.
(c) *Cement*: Classification of cement, ingredients and their role. Manufacture of cement and the setting process, quick setting cements.

Unit 2: Batteries **8 Hours**
Primary and secondary batteries, battery components and their role and characteristics of battery. Working of following batteries: Pb acid Battery, Li-ion Battery, Fuel Cells, and Solar cell

Unit 3: Fertilizers **8 Hours**
Different types of fertilizers (N, P and K). Importance of fertilizers, chemistry involved in the manufacture of the following fertilizers: urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates, superphosphate of lime, potassium chloride and potassium nitrate.

Practical components **(Laboratory periods: 60)**

1. Detection of constituents of Dolomite (Calcium, Magnesium and carbonate ions) by qualitative analysis.
2. Determination of composition of Dolomite using complexometric titration.
3. Detection of constituents of Ammonium Sulphate fertilizer (Ammonium and Sulphate ions) by qualitative analysis.
4. Determine its free acidity in Ammonium Sulphate fertilizer.
5. Detection of constituents of CAN fertilizer (Calcium, Ammonium and Nitrate ions) by qualitative analysis.
6. Estimation of Calcium content in CAN fertilizer.

7. Detection of constituents of Superphosphate fertilizer (Calcium and Phosphate ions) by qualitative analysis.
8. Estimation of phosphoric acid content in Superphosphate fertilizer.
9. To determine the total insoluble residue in the cement sample.
10. To determine the amount of lime (CaO) in the given sample of cement.
11. To determine the silica content in the given sample of cement.
12. To determine the Oxides (Sesquioxides Fe_2O_3 + Al_2O_3) in the given sample of cement.

Essential/recommended readings

Theory:

1. Felder, R. M.; Rousseau, R. W. (2015), **Elementary Principles of Chemical Processes**, Wiley Publishers, New Delhi.
2. Stocchi, E. (1990), **Industrial Chemistry**, Vol -I, Ellis Horwood Ltd. UK.
3. Kingery, W. D.;Bowen, H. K.;Uhlmann, D. R. (1976), **Introduction to Ceramics**, Wiley Publishers, New Delhi.
4. Kent, J. A. (ed**)** (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
5. Jain, P. C.; Jain, M. (2013), **Engineering Chemistry**, Dhanpat Rai & Sons, Delhi.
6. Sharma, B. K. (2014), **Engineering Chemistry**, Goel Publishing House, Meerut

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis,** John Wiley and Sons.
2. Svehla, G.(1996),**Vogel's Qualitative Inorganic Analysis**, Prentice Hall.
3. Banewicz, J. J.; Kenner, C.T. **Determination of Calcium and Magnesium in Limestones and Dolomites**, Anal. Chem., 1952, 24 (7), 1186–1187.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 8: Chemical Energetics and Equilibria

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics and Equilibria (DSC-8: Chemistry -III)	04	02	0	02	Class XII Pass with Physics, Chemistry, Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop basic understanding of the chemical energetics, laws of thermodynamics and ionic equilibrium.
- To provide basic understanding of the behaviour of electrolytes and their solutions.
- To give an overview of the properties of ideal and real gases and deviation from ideal behaviour.

Learning outcomes

By the end of the course, the students will be able to:

- Explain the laws of thermodynamics, thermochemistry and equilibria.
- Illustrate the concept of pH and its effect on the various physical and chemical properties of the compounds.
- Explain and draw the concepts to predict feasibility of chemical reactions and to study the behaviour of reactions in equilibrium.

SYLLABUS OF DSC-8

Unit 1: Chemical Energetics **16 Hours**

Recapitulation of Intensive and extensive variables; state and path functions; isolated, closed and open systems, concept of heat, Q, work, W, internal energy, U, and enthalpy, H.

First law

Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities for ideal gas, Joule's experiment, calculations of Q, W, ΔU and ΔH for reversible expansion of ideal gases under isothermal conditions.

Thermochemistry

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of ionization enthalpy of hydration, enthalpy of formation and enthalpy of combustion, Integral enthalpy of solution, bond dissociation energy and bond enthalpy; Hess's law, Born Haber's cycle (NaCl/ KCl).

Second Law

Concept of entropy; statements of the second law of thermodynamics (Kelvin and Clausius). Calculation of entropy change for reversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy (Non-PV work and the work function); Free energy change and concept of spontaneity (for ideal gases).

Third Law

Statement of third law, qualitative treatment of absolute entropy of molecules (examples of NO, CO), concept of residual entropy

Unit 2: Chemical Equilibrium **4 Hours**

Criteria of thermodynamic equilibrium. Free energy change in a chemical reaction and equilibrium constant, exergonic and endergonic reactions with examples such conversion of ATP to ADP or vice versa,, Le Chatelier's principle, relationship between Kp, Kc and Kx for reactions involving ideal gases.

Unit 3: Ionic Equilibria **10 Hours**

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, Degree of ionization, pH scale, common ion effect, Buffer solutions, Henderson-Hasselbach equation. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle

Practicals components **(Laboratory periods: 60)**

Chemical Energetics:

1. Determination of heat capacity of calorimeter.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of the enthalpy of ionization of acetic acid.
4. Determination of enthalpy of neutralization of acetic acid and ammonium hydroxide using Hess's law.
5. Determination of integral enthalpy of solution (both endothermic and exothermic)

of salts.

6. Determination of enthalpy of hydration of Copper sulphate.

Ionic equilibria:

7. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammonium chloride-ammonium acetate. Measurement of the pH of buffer solutions and comparison of the values with theoretical values.
8. Study the effect of addition of HCl/NaOH on pH of the buffer solutions (acetic acid, and sodium acetate).
9. Titration of strong acid with strong base using pH meter.

Essential/recommended readings

Theory:

1. Castellan, G. W. (2004), **Physical Chemistry**, Narosa.
2. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K. L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6thEdition, McGraw Hill Education.
4. Puri, B. R., Sharma, L. R. and Pathania M. S. (2020), **Principles of Physical Chemistry**, Vishal Publishing Co.

Practical:

1. Khosla, B. D.; Garg, V. C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co.
2. Kapoor, K. L. (2019), **A Textbook of Physical Chemistry**, Vol 7, 1st Edition, McGraw Hill Education.
3. Batra, S. K., Kapoor, V and Gulati, S. (2017) 1st Edition, **Experiments in Physical Chemistry,** Book Age series.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.