

6. Analysis of cosmetics

Major and minor constituents of cosmetics and their functions, analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate

9 Hours

Reference Books

1. Willard, H.H., Merritt, L.L., Dean, J. & Settoe, F.A. Instrumental Methods of Analysis, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
2. Skoog, D.A., Holler, F.J. & Crouch, S. Principles of Instrumental Analysis, Cengage Learning India Edition, 2007.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Analytical Chemistry: An Introduction sixth Ed., Saunders College Publishing, Fort Worth, Philadelphia (1994).
4. Harris, D. C. Quantitative Chemical Analysis, 9th ed. Macmillan Education, 2016.
5. Dean, J. A. Analytical Chemistry Handbook, McGraw Hill, 2004.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India, 1992.
7. Freifelder, D.M. Physical Biochemistry 2nd Ed., W.H. Freeman & Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley & Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
10. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).
12. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

Semester-III

Chemistry MAJOR

Paper code: CHEM3011 (3 and 4 years)
 Paper title: Inorganic Chemistry (Theory)
 Credit: 5

Course objective

- Discussion of bonding theories (advanced parts)
- Application of the basic theories discussed so far towards coordination chemistry and s- and p-block elements

Course outcome

After studying several basic aspects of chemistry, students will go through their applications in studying coordination chemistry, s- and p-block elements. On studying different comparative properties s- and p-block elements, proper chemical logic will start to be developed among the students.

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1. Chemical Bonding-II

Molecular orbital concept of bonding (The approximations of the theory, Linear combination of atomic orbitals (LCAO) (elementary pictorial approach): sigma and pi-bonds and delta interaction, multiple bonding. Orbital designations: gerade, ungerade, HOMO, LUMO. Orbital mixing, MO diagrams of H₂, Li₂, Be₂, B₂, C₂, N₂, O₂, F₂, and their ions wherever possible; Heteronuclear molecular orbitals: CO, NO, NO⁺, CN⁻, HF, BeH₂, CO₂ and H₂O. Bond properties: bond orders, bond lengths.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids – stoichiometric and non-stoichiometric.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Intermolecular forces: Hydrogen bonding (theories of hydrogen bonding, valence bond treatment), receptor-guest interactions, Halogen bonds. Effects of chemical force, melting and boiling points.

20 Hours

2. Coordination Chemistry-I

Double and complex salts. Werner's theory of coordination complexes, Classification of ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, Geometrical and optical isomerism in square planar and octahedral complexes.

12 Hours

3. Chemistry of s and p-block elements

Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Beryllium hydrides and halides. Boric acid and borates, boron nitrides, borohydrides (diborane) and

graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus, sulphur and chlorine. Peroxo acids of sulphur. Sulphur-nitrogen compounds, Basic properties of halides and polyhalides, interhalogen compounds, pseudohalides, fluorocarbons and chlorofluorocarbons. 35 Hours

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation, structures (VSEPR theory) and properties of XeF_2 , XeF_4 and XeF_6 ; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2 and XeF_4). Xenon-oxygen compounds. 8 Hours

Reference Books

- 1) Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson, 2006
- 2) Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth-Heinemann, 1997
- 3) Cotton, F.A., Wilkinson, G., Murrillo, C. A., Bochmann, M., Advanced Inorganic Chemistry, 6th Ed. 1999., Wiley
- 4) Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010
- 5) Purecell, K.F. and Kotz, J.C., An Introduction to Inorganic Chemistry, Saunders: Philadelphia, 980
- 6) Mingos, D.M.P., Essential trends in inorganic chemistry. Oxford University Press (1998)
- 7) Sarkar, R, General and inorganic chemistry, Volume II, New central book agency, (2012)

Chemistry MAJOR

Paper code: CHEM3012 (3 and 4 Years)

Paper title: Inorganic Chemistry (Practical)

Credit: 5

Course objective

- Development of chemical knowledge through several hands-on qualitative experiments
- Learning to synthesize several coordination compounds

Course outcome

Towards qualitative detection of several radicals, different experiments have to be covered. These will actually grow a clear knowledge and conception in chemistry. Moreover, preparation of modern coordination compounds will create an insight to the synthetic coordination chemistry.

1. *Qualitative analysis of Acid and Basic radicals from an inorganic sample* containing four radicals (oxide, hydroxide and carbonate may not be counted among four radicals). Emphasis should be given to the understanding of the chemistry of different reactions and to assign the most probable composition. Semi-micro analysis may also be followed. The use of centrifuge machine, thioacetamide instead of H₂S and spot tests for specific radicals should be introduced

Basic radicals: Na⁺, K⁺, Ca²⁺, Sr²⁺, Ba²⁺, Al³⁺, Cr³⁺, Mn²⁺/Mn⁴⁺, Fe²⁺/Fe³⁺, Co²⁺/Co³⁺, Ni²⁺, Cu²⁺, Zn²⁺, Pb²⁺, Cd²⁺, Bi³⁺, Sn²⁺/Sn⁴⁺, As³⁺/As⁵⁺, Sb³⁺/Sb⁵⁺, NH₄⁺, Mg²⁺.

Acid Radicals: F⁻, Cl⁻, Br⁻, I⁻, S₂O₃²⁻, S²⁻, SO₄²⁻, SO₃²⁻, NO₃⁻, NO₂⁻, PO₄³⁻, AsO₄³⁻, BO₃³⁻, CrO₄²⁻.

Insoluble Materials: Al₂O₃ (ig), Fe₂O₃ (ig), Cr₂O₃ (ig), SnO₂, SrSO₄, BaSO₄, CaF₂, PbSO₄.

45 Hours

2. Inorganic preparations

- 1) [Cu(CH₃CN)₄]PF₆/ClO₄
- 2) Potassium dioxalatodiaquachromate(III)
- 3) Tetraamminecarbonatocobalt(III) ion
- 4) Potassium tris(oxalato)ferrate(III)

- 5) Tris(ethylenediamine) nickel(II) chloride
- 6) $[\text{Mn}(\text{acac})_3]$ and $[\text{Fe}(\text{acac})_3]$ (acacH = acetylacetone)

30 Hours

Reference Books

- 1) Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall, 1996.
- 2) Karmakar, P., Sarkar (Sain), R., Ray, S., Ghosh, A.K. Concise Practical Chemistry (B.Sc. General and Honours), PART-I, The New Book Stall, Kolkata (2018).
- 3) Ghosh, Das Sharma, Majumdar, Manna, Chemistry in Laboratory, Santra Publication (P) Ltd.
- 4) Ghoshal, A., Mahapatra, B., Nad, A. K. An Advanced Course in Practical Chemistry, New Central Book Agency (2007).
- 5) Bhattacharyya, R. C, A Manual of Practical Chemistry.
- 6) K. S. Mukherjee, Textbook on Practical Chemistry, New Central Book Agency (P) Ltd.

MULTIDISCIPLINARY

Paper code: CHEM3031

Paper title: Chemistry of Soil, Fertilizer and detergent

Credit: 3

Course objective

- Development of knowledge of soil
- Development of knowledge of fertilizer
- Idea of pesticide, etc
- Idea of development of several surface-active agents like soap, etc

Course outcome

Exploring the knowledge of fundamental chemistry towards soil, fertilizer, detergent will not only create general chemical knowledge of the students but also will generate the possibility of employability.

1. Soil: Composition, texture, micro & macro nutrients, soil health, soil conditioner, growth factor, NPK and their determination, soil productivity and effect of pH

10 hours

2. Fertilizer: Different types of fertilizers. Manufacture of the following fertilizers: Urea, ammonium nitrate, calcium ammonium nitrate, ammonium phosphates; polyphosphate, superphosphate, compound and mixed fertilizers, potassium chloride, potassium sulphate.

15 hours

3. Fungicide, pesticide, herbicide with examples, advantage and disadvantage. *10 hours*

4. Soap & Detergents: Different types of soap and detergents with example, surface active and surface inactive substances *10 hours*

Reference Books

- 1) Thapar, Food Chemistry, Pacific Book International
- 2) Gayatri Baidya, Textbook of Food Chemistry, Book Rivers
- 3) Mandal, S.K., Pharmaceutical Chemistry and Production: An Introductory Textbook
Rebeca Ghanta; Bentham Science Publishers 2022, ISBN: 978-1-68108-890-7
- 4) Sengupta, S. Application Oriented Chemistry Books Syndicate Pvt. Ltd., 2000

SKILL ENHANCEMENT COURSE

Paper code: CHEM3051

Paper title: IT skills in Chemistry

Credit: 3

Course objective

- Development of mathematical knowledge and knowledge for computer programming
- Development of knowledge for different data handling softwares

Course outcome

The course will help the students sound for doing several chemical computations.

Mathematical tools

1. Fundamentals: mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs.
2. Uncertainty in measurement: Displaying uncertainties, types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression).

3. Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary-bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

4. Differential calculus: The tangent line and the derivative of a function, numerical differentiation (e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations).

5. Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).

15 Hours

Computer Programming

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Fortran or C programming for curve fitting, numerical differentiation and integration (Trapezoidal rule, Simpson's rule), finding roots (quadratic formula, iterative, Newton-Raphson method).

15 Hours

Handling numeric data

Spreadsheet software (Excel), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs. Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.

15 Hours

Reference Books

- 1) McQuarrie, D. A. Mathematics for Physical Chemistry University Science Books (2008).

- 2) Mortimer, R. Mathematics for Physical Chemistry. 3rd Ed. Elsevier (2005).
- 3) Steiner, E. The Chemical Maths Book Oxford University Press (1996).
- 4) Yates, P. Chemical calculations. 2nd Ed. CRC Press (2007).
- 5) Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5.
- 6) Levie, R. de. How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press (2001) 487 pages.
- 7) Noggle, J. H. Physical chemistry on a Microcomputer. Little Brown & Co. (1985).
- 8) Venit, S.M. Programming in BASIC: Problem solving with structure and style. Jaico Publishing House: Delhi (1996).

Semester-IV

Chemistry MAJOR

Paper code: CHEM4011 (3 and 4 Years)

Paper title: Organic Chemistry (Theory)

Credit: 5

Course objective

Development of knowledge for several basic and advanced topics of organic chemistry

Course outcome

The course will help the students to develop a complete knowledge on stereochemistry, reaction mechanism and others of organic chemistry.

1. Stereochemistry II

Chirality arising out of stereoaxis: stereoisomerism of substituted cumulenes with even and odd number of double bonds; chiral axis in allenes, spiro compounds, alkylidenecycloalkanes and biphenyls; related configurational descriptors (R_a/S_a and P/M); atropisomerism; racemisation of chiral biphenyls; buttressing effect.

Concept of prostereoisomerism: prostereogenic centre; concept of (pro)n-chirality: topicity of ligands and faces (elementary idea); pro-R/pro-S, pro-E/pro-Z and Re/Si descriptors; pro-r and pro-s descriptors of ligands on propseudoasymmetric centre.