

# **SHIVAJI UNIVERSITY, KOLHAPUR.**



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Accredited By NAAC with 'A' Grade

**CHOICE BASED CREDIT SYSTEM**

Syllabus For

**B.Sc. Part - I**

**Chemistry**

**SEMESTER I AND II**

**(Syllabus to be implemented from June, 2018 onwards.)**

**B. Sc. I Semester I****DSC-3A- Chemistry paper I (Inorganic Chemistry)  
(Theory Credits: 02 : 30 Lectures)****Unit I: Atomic Structure and Periodicity of Elements (09)**

- 1.1 Bohr's theory of hydrogen atom and its limitations
- 1.2 Wave particle duality
- 1.3 Heisenberg uncertainty principle
- 1.4 Quantum numbers and their significance
- 1.5 Shapes of *s*, *p* and *d* atomic orbitals
- 1.6 Electrons filling rules in various orbitals: a) Aufbau's principle b) Hund's rule of maximum multiplicity c) Pauli's exclusion principle
- 1.7 Electronic configuration of elements. Stability of empty, half-filled and completely filled orbitals
- 1.8 Periodicity of the elements: General discussion of the following properties of the elements with reference to s block elements: a) electronic configuration b) atomic radii c) ionic radii d) ionization energy e) electron affinity f) electronegativity g) metallic characters h) reactivity i) oxidation state j) melting and boiling points k) chemical properties

**Unit II: Chemical Bonding and Molecular structure (A) Ionic Bonding (07)**

- 2:1 Definition and formation of ionic bond. General characteristics of ionic bonding
- 2:2 Energetic in Ionic bond formation
- 2:3 Born-Haber cycle for NaCl and its applications
- 2:4 Fajan's Rule, Applications of Fajan's rule for,
  - Polarizing power and polarizability
  - Ionic character in covalent compounds
  - Bond moment, dipole moment and percentage ionic character

**Unit III: Chemical Bonding and Molecular structure (B) Valence bond theory (VBT). (07)**

- 3.1 Concept of hybridization, different types of hybridization and geometry of following molecules,
  - Linear geometry-  $\text{BeCl}_2$  ( *sp* hybridization )

- Planer trigonal geometry-  $\text{BF}_3$  ( $\text{sp}^2$  hybridization )
- Tetrahedral geometry-  $\text{SiCl}_4$  ( $\text{sp}^3$  hybridization)
- Trigonal bipyramidal geometry-  $\text{PCl}_5$  ( $\text{sp}^3\text{d}$  hybridization )
- Octahedral geometry-  $\text{SF}_6$  ( $\text{sp}^3\text{d}^2$  hybridization )
- Pentagonal bipyramidal geometry - $\text{IF}_7$  ( $\text{sp}^3\text{d}^3$  hybridization)

#### Unit IV: Chemical Bonding and Molecular structure (C) Molecular orbital theory (MOT)

(07)

- 4.1 LCAO method, formation of bonding , anti bonding and nonbonding molecular orbitals.
- 4.2 Conditions for successful overlap, Types of overlaps - S-S ,S-px, Px-Px, Py-Py and Pz-Pz overlaps.
- 4.3 Bond order and its significance.
- 4.4 Energy level sequence for molecular orbital when  $n=1\&2$ .
- 4.5 MO diagrams for homonuclear diatomic molecule of 1<sup>st</sup> & 2<sup>nd</sup> period Elements (  $\text{He}_2$ ,  $\text{Li}_2$ ,  $\text{B}_2$ ,  $\text{N}_2$ ,  $\text{O}_2$ ).
- 4.6 Molecular orbital diagrams for heteroatomic diatomic molecules. ( $\text{CO}$ ,  $\text{NO}$  )

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#### Reference Books:

- 1) Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- 2) Cotton, F.A., Wilkinson, G. & Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- 3) Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- 4) Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:*
- 5) Principles of Structure and Reactivity, Pearson Education India, 2006.
- 6) Puri, Sharma, Kalia. *Principles of Inorganic Chemistry*
- 7) Madan R. L. *Chemistry for Degree Students( B. Sc. First year)*, S. Chand Publications

**B. Sc. I Semester I****DSC-4A- Chemistry paper II (Organic Chemistry)  
(Credits: 02 : 30 Lectures)****Unit I: Fundamentals of Organic Chemistry (08)**

Introduction, Curved arrow notations, Cleavage of Bonds: Homolysis and Heterolysis. Organic molecular species: Nucleophiles and electrophiles. Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation effect, Reactive Intermediates: Generation, Structure, Stability and Reactions of Carbocations, Carbanions and carbon free radicals.

**Unit II: Stereochemistry (09)****Hrs**

Introduction, Types of Stereoisomerism, Optical Isomerism: Concept of Chirality, Elements of Symmetry, Optical Isomerism in tartaric acid, 2, 3 Dihydroxybutanoic acid, Enantiomerism, Diastereomerism and Meso compounds, Geometrical isomerism in C=C, C=N and alicyclic compounds. Nomenclature of stereoisomers: D and L, erythro and threo, R and S, E and Z.

**Unit III: Aromaticity (07)**

Introduction, Characteristics properties of organic compounds, Meaning of terms: Aromatic, Non aromatic, Antiaromatic, Pseudoaromatic, Structure of Benzene: Kekule structure, Resonance structure, M.O. picture, Modern theory of Aromaticity, Mechanism of Electrophilic substitution reactions: Nitration, Sulphonation, Halogenation and Friedel craft reaction.

**Unit IV: Cycloalkanes, cycloalkenes and alkadienes (06)**

Cycloalkanes: - Introduction. Method of formation - a) By addition of carbene to alkene b) Action of metallic sodium on dihaloalkane c) Diels - Alder reaction d) By reduction of aromatic compounds, Chemical properties- a) Photohalogenation b) Catalytic halogenations c) Catalytic hydrogenation d) Effect of heat e) Reaction with hydrogen halide

Cycloalkenes : Introduction, Method of formation from cyclic compounds, Chemical Properties - a) Hydrogenation b) Addition of Halogens and halogen acids, c) Allylic halogenations

Alkadienes : Introduction, Classification, Buta-1,3-diene - a) Structure b) Methods of formation - from cyclohexane, From Butane by dehydrogenation, From acetylene, From Butane-1,3 - diol, From ethanol and acetaldehyde (Industrial method), Chemical Properties - a) Reaction with hydrogen halide b) Reaction with halogens -With one molar equivalent of halogens ( $\text{Cl}_2$  or  $\text{Br}_2$ ) c) Diels- Alder reaction d) Reduction – hydrogenation e) Oxidation – Ozonolysis f) Polymerization

### Reference Books:

- 1) Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- 2) McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- 3) Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- 4) Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- 5) Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- 6) Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- 7) Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- 8) D.Nasipuri :Stereochemistry of Organic compounds
- 9) R. L. Madan, Chemistry for Degree Students (B. Sc. First Year), S. Chand.Publication

**CHEMISTRY-DSC 3B: Chemistry Paper-III (Physical Chemistry)****(Credits :02 , Lectures-30)****Unit -I Chemical Energetics (06)****A) Thermodynamics**

Introduction, Basic concepts of thermodynamics, First law of thermodynamics Spontaneous and non-spontaneous process with examples, Statements of second law of thermodynamics, Carnot's cycle and its efficiency. Entropy, Physical Significance of entropy, Statement of Third Law of thermodynamics and calculation of absolute entropies of substances

**B) Thermochemistry (04)**

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

**Unit II . Chemical Equilibrium: (06)**

Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**Unit- III. Kinetic Theory of Gases (07)**

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Ideal and Non ideal gases, Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Explanation of real gas behaviour by Van der Waal's equation, Boyle temperature (derivation not required). Critical Phenomena: PV-isotherms of real gases (Andrew's isotherms), Continuity of state, Critical constants and their calculation from vander Waals equation. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence

of these distributions. Most probable, average and root mean square velocities (no derivation).  
Numerical Problems.

#### **Unit- IV. Chemical Kinetics**

**(07)**

Introduction, Rate of reaction, Definition and units of rate constant, Factors affecting rate of reaction. (Nature of reactant, Concentration, pressure, temperature and catalyst.) Order and Molecularity of reaction, Zero order reaction, First order reaction, Characteristics of first order reaction.examples, Pseudo-unimolecular reactions,examples. Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Characteristics of Second order reaction., Determination of order of reaction by i) integration method ii) graphical method iii) Half life method, Effect of temperature on rate of reaction, Arrhenius equation, Concept of energy of activation.

Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only). Numerical problems.

#### **Reference Books:**

1. Principles of Physical Chemistry Puri, Sharma and Pathania, Vishal Publishing House, 44th Edition
2. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36th Edition
3. Essentials of Physical Chemistry, Bahl, Tuli and Bahl
4. Text Book of Physical Chemistry, Soni and Dharmarha
5. Essentials of Nuclear Chemistry by H J Arnika, New Age, 4th edition.
6. Mathematical preparation of Physical Chemistry : F. Daniel, Mc-Graw Hill Book Company Ltd.
7. Elements of Physical Chemistry : S. Glasstone and D.Lewis  
(D.Van Nostrand Co.Inc)
8. Physical Chemistry : W. J. Moore (Orient Longman)
9. Principles of Physical Chemistry : Maron Prutton
10. University Chemistry : B. H. Mahan (Addison - Wesley Publ. Co.)
11. Chemistry for Degree students(B. Sc. First Year): R L Madan (S. Chand and Company)

**B.Sc. I Semester II**  
**DSC-4B-Chemistry Paper IV (Analytical Chemistry)**  
**(Theory Credits:02, Lectures-30)**

- 1. Introduction to analytical Chemistry (06)**
  - 1.1 Introduction
  - 1.2 Importance of analysis
  - 1.3 Analytical processes (Qualitative and Quantitative)
  - 1.4 Methods of analysis (Only classification)
  - 1.5 Sampling of solids, liquids and gases
  - 1.6 Errors, types of errors (determinate and indeterminate), methods of expressing accuracy (Absolute and relative error)
  - 1.7 Significant figures, mean, median, standard deviation (Numerical problems expected)
  
- 2. Chromatography (06)**
  - 2.1 Introduction, Basic Principle of Chromatography, Basic terms, Classification of Chromatography
  - 2.2 Paper Chromatography- Principle, Methodology-types of papers and treatment, sample loading, choice of solvent, development-ascending, descending, circular, location of spots, determination of  $R_f$  value, Applications, advantages and disadvantages
  - 2.3 Thin layer chromatography; Principle, Solvent system, stationary phases, preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot,  $R_f$  value, Applications, advantages and disadvantages
  - 2.4 Comparison of paper chromatography and TLC
  
- 3. Theory of titrimetric Analysis (06)**
  - 3.1 Introduction
  - 3.2 Acid-base indicators
  - 3.3 Theory of indicators w.r.t. Ostwald's ionization theory and quinoid theory
  - 3.4 Neutralization curves and choice of indicators for
    - a. Strong acid-strong base
    - b. Strong acid-weak base
    - c. Strong base-weak acid
  - 3.5 Complexometric titrations
    - a. Introduction
    - b. Types EDTA titrations
    - c. Metallochromic indicators-Eriochrome black- T
    - d. Indicator Action of Eriochrome black- T



- 4. Water Analysis** (06)
- 4.1 Physical analysis of water – pH, Conductance, Colour, odour, Turbidity and taste
  - 4.2 Chemical Analysis – Total Dissolved solids , Hardness, Salinity, Alkalinity, Acidity, Sulphates, Nitrates, Dissolved Oxygen, Chemical Oxygen Demand, Biological Oxygen Demand
- 5. Analysis of Fertilizers** (06)
- 5.1 Introduction
  - 5.2 Types of fertilizers
  - 5.3 Necessity and requirements of good fertilizers
  - 5.4 Sampling and sample preparation
  - 5.5 Analysis of Nitrogen by Kjeldahl's method
  - 5.6 Analysis of Phosphorus by phosphomolybdate method
  - 5.7 Analysis of Potassium by sodium tetraphenyl borate method

**References:**

1. Textbook of quantitative Inorganic analysis-A.I. Vogel
2. Instrumental methods of Chemical analysis-H. Kaur
3. Instrumental methods of Chemical analysis-B.K. Sharma
4. Instrumental methods of Chemical analysis-Chatwal Anand
5. Fundamental of analytical Chemistry-Skoog and West
6. Basic Concepts of analytical Chemistry-S.M. Khopkar
7. Analytical Chemistry-Alka Gupta (Pragati Prakashan)
8. Indian Pharmacopoeia
9. Chromatography-H. Kaur
10. Chemistry for Degree students(B.Sc. First Year): R. L. Madan (S. Chand and Company)

**B.Sc. I Semester I and II  
Practical Course**

**(Credits 02: Lectures-04per week)**

**A) Inorganic Chemistry (Any Six)**

1. To prepare standard 0.1 N  $\text{KMnO}_4$  solution and to determine the strength of given oxalic acid solution.
2. To determine quantity of  $\text{Fe(II)}$  ions from the given solutions by titrating it with 0.1 N  $\text{K}_2\text{Cr}_2\text{O}_7$  solution by using internal indicator
3. To estimate amount of  $\text{Cu(II)}$  ions by iodometric titration by using  $\text{Na}_2\text{S}_2\text{O}_3$  solution.
4. To standardize supplied EDTA solution by titrating with 0.01 M  $\text{ZnSO}_4$  solution and to estimate amount of calcium from given solution by using Erio-T as an indicator.
5. Quality control-To determines percentage purity of the given sample of soda ash  $\text{Na}_2\text{CO}_3$  by titrimetric method.
6. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method
7. Chromatography : Separation and identification of cations by Paper Chromatographic technique from the following mixtures :
  - a)  $\text{Ni}^{2+} + \text{Cu}^{2+}$
  - b)  $\text{Ni}^{2+} + \text{Co}^{2+}$

**B) Organic Chemistry**

1. **Estimations** (any two) :
  1. Estimation of aniline. (by bromination method)
  2. Estimation of acetamide.
  3. Estimation of Aspirin.
2. Organic Qualitative Analysis: Detection of physical constant, type, functional group, elements, and Confirmatory test.

Identification of Organic Compounds (at least eight) (four containing at least one extra element- N, S, Cl, Br, I)

  - a) Acids: Oxalic acid, Benzoic acid, cinnamic acid
  - b) Phenols: Beta-Naphthol, Resorcinol
  - c) Base: Aniline, p-Nitroaniline

d) Neutral: Acetone, Acetanilide, Chloroform, m-Dinitrobenzene, Thiourea, Bromobenzene

3. Purification of organic compounds by crystallization (from water and alcohol) and distillation.

**References:**

- 1) Vogel's Text Book of Quantitative Chemical Analysis. (Longmann) ELBS Edition.
- 2) Vogel's Text Book of Qualitative Chemical Analysis. (Longmann) ELBS Edition.
- 3) Hand book of Organic Qualitative Analysis : Clarke.
- 4) Comprehensive Practical Organic Chemistry – Qualitative Analysis by V. K. Ahluwalia, Sunita Dhingra. University Press. Distributor – Orient Longman Ltd.
- 5) Comprehensive Practical Organic Chemistry preparation and Quantitative Analysis : V. K. Ahluwalia, Renu Aggarwal. University Press. Distributor – Orient Longman Ltd.
- 6) A Laboratory Hand - Book of Organic Qualitative Analysis and Separation : V. S. Kulkarni. Dastane Ramchandra & Co. Pune

**C) Physical Chemistry**

**Physical Chemistry (Any Six)**

1. Determination of equivalent weight of Mg by Eudiometer.
2. Study of specific reaction rate of hydrolysis of methyl acetate in presence of HCl.
3. Determination of heat of ionization of weak acid by using polythene bottle.
4. Determination of heat capacity of calorimeter for different volumes.
5. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
6. Determination of integral enthalpy of solution of salts ( $\text{KNO}_3$ ,  $\text{NH}_4\text{Cl}$ ).
7. Determination of enthalpy of hydration of copper sulphate.
8. Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .

**References:**

- 1) Practical book of Physical Chemistry: Nadkarni, Kothari & Lawande.

- 2) Experimental Physical Chemistry: A. Findlay.
- 3) Systematic Experimental Physical Chemistry: S. W. Rajbhoj, Chondhekar.  
(Anjali Publication.)
- 4) Experiments in Physical Chemistry: R. C. Das and B. Behra. (Tata Mc Graw Hill)
- 5) Advanced Practical Physical Chemistry: J. B. Yadav (Goel Publishing House.)
- 6) Practical Physical Chemistry: B. D. Khosala. (R. Chand & Sons)
- 7) Experiments in Chemistry: D. V. Jahagirdar.
- 8) A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis: A.I. Vogel (Third Ed.) (ELBS)

# **SHIVAJI UNIVERSITY, KOLHAPUR.**



**Accredited By NAAC with 'A' Grade**

**Revised Syllabus For  
Bachelor of Science**

**Part-II  
Chemistry  
CBCS PATTERN**

**Syllabus to be implemented from**

**June, 2019 onwards.**

## B.Sc.Part II (CBCS) Sem III

### Paper No. DSC- C3 - Chemistry paper No. V (Physical Chemistry)

(Theory Credits: 02 : 30 hours, 38 lectures)

Name of the Topics	Expected Learning Outcome
1 Electrolytic Conductivity	Learning and understanding conductivity and transport number of the aqueous solutions with different applications.
2 Physical Properties of Liquids	Knowledge about surface tension, viscosity and refractive index will be gained by the student
3 Surface Chemistry	Learning and understanding surface phenomena at heterogeneous surfaces
4 Nuclear Chemistry	Learning the various Nuclear phenomena and measurement of nuclear radiations
5 Chemical Kinetics	Learning and understanding the knowledge about third order reaction and theories of reaction rates

#### Unit- I Electrolytic Conductivity

(16L)

Introduction, Types of conductors, Conductivity, Equivalent and Molar conductivity and their variation with dilution for weak and strong electrolytes in aqueous solution. Equivalent conductivity at infinite dilution, Measurement of conductance by using Wheatstone bridge. Kohlrausch law of independent migration of ions and its applications such as Ionic mobility, determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of salt. Conductometric titrations (only acid base titrations). Advantages of conductometric titrations.

Transference number, Hittorf's rule, determination of transport number using Moving boundary method, factors affecting transport numbers. Numerical problems.

#### Unit- II Physical Properties of Liquids

(6L)

Introduction, Classification of physical properties, Surface tension and its determination using Stalagmometric and differential capillary rise methods, Viscosity and its determination using Ostwald's viscometer, Refractive index (Snell's law), Specific and Molecular refractivities and its determination using Abbe's refractometer.

#### Unit – III Surface Chemistry

(7L)

Introduction, Adsorption as a surface phenomenon, Definition of adsorption, adsorbent, adsorbate, adsorbent. factors affecting adsorption, Types of adsorption, Distinction between physical and chemical adsorption, Adsorption isotherms: Freundlich adsorption isotherm, Langmuir adsorption isotherm. Types of physical adsorption isotherms, applications of adsorption.

#### Unit – IV Nuclear Chemistry

(5L)

Introduction, Types of Nuclear radiation, properties of  $\alpha$ ,  $\beta$  and  $\gamma$  radiations, Detection and measurement of nuclear radiations by Scintillation and Geiger muller counter methods, radioactive equilibrium and range of  $\alpha$ - particles, Geiger Nuttal relations, determination of radioactive constant (decay constant).

Introduction, Third order reactions: derivation of rate constant, characteristics and examples of third order reaction. Theories of reaction rates as Collision theory and Transition state theory (only quantitative aspect, derivation not expected),

**Reference Books:**

- 1) Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- 2) Castellan G.W. Physical Chemistry 4<sup>th</sup> Ed. Narosa (2004).
- 3) Kotz, J.C. Treichel, P.M.& Townsend, J.R. General Chemistry, Cengage Learning India Pvt Ltd: New Delhi (2009).
- 4) Mahan, B.H. University Chemistry, 3<sup>rd</sup> Ed. Narosa (1998).
- 5) Petrucci, R.H. General Chemistry, 5<sup>th</sup> Ed., Macmillan Publishing Co.,: New York (1985).
- 6) Elements of Physical Chemistry S., Glasstone, D. Lewis.(2010)
- 7) Principles of physical Chemistry Marron and Prutton. (2007).
- 8) Elements of Physical Chemistry P.W. Atkins (2017)
- 9) Essentials of Physical Chemistry Bahl and Tuli. S. Chand, 2010.
- 10) Physical Chemistry Daniels and Alberty (2016)
- 11) University General Chemistry C.N.R. Rao (2016)
- 12) Principals of Physical Chemistry Puri, Sharma and Pathania 47<sup>th</sup> Edition, Vishal Publishing Co. Daryaganj Delhi. 110002 (2017)
- 13) Physical Chemistry A.J. Mee.(2015)
- 14) Advanced Physical Chemistry Gurudeep Raj (2017)
- 15) Physical Chemistry R.A. Alberty.(2017-18)
- 16) Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).

## B.Sc.Part II (CBCS) Sem III

### Paper No. DSC-C4- Chemistry paper No. VI (Industrial Chemistry)

(Theory Credits: 02 : 30 hours, 38 lectures)

Expected learning Outcomes :

Name of the topic	Expected Learning Outcome
1.Basic concepts in Industrial Chemistry	a.Learning and Understanding basic concepts and concentration terms b.Distinguish between classical and industrial chemistry c. Distinguish between unit operations and unit processes
2. Unit Operations	Knowledge of some unit operations
3.Corrosion and Electroplating	Understanding the process of corrosion and Knowledge of prevention from corrosion
4.Paper Industry	Knowledge of Indian paper industry
5.Soap and Detergents	Knowledge about the chemical nature and cleansing action of soap

#### Unit I Basic Concepts in Industrial Chemistry(10)

The difference between classical chemistry and industrial chemistry, Raw material for the Chemical Industry,Material Safety data sheets,Units that make up a chemical process-unit operation and unit processes, Flow Diagrams,Block Diagram, Process flow diagram / flow sheets, Material Balances-The purpose of mass balance calculations,Material Balance Equations,Mass balance calculation procedure and simple example

Definition and Explanation of terms -Normality, Equivalent weight, Molality, Molecular weight,Molarity, Molarity of mixed solution, Acidity of base, Basicity of acid,ppt, ppm, ppb solutions, Mole Fraction, Weight fraction, Percentagecomposition by W/W, W/V, V/V, Problems based on Normality, Molarity, mole fraction, mixed solution, etc.

#### Unit II Unit Operations(06)

Size reduction- Principle,Jaw crusher,ball mill

Size Enlargement –Principle,Pellet mill,tumbling agglomerators

Separation – Magnetic separation,Froth flotation,Distillation-Distillation of liquid mixtures, Types of distillation, Types of columns and packings, Condensers, Vacuum distillation, Spinning-banddistillation, Steam distillation.

#### Unit III. Corrosion and Electroplating (09)

Introduction of corrosion, Electrochemical theory of corrosion,Factors affecting on corrosion -i. Position of metals in the electrochemical series on the basis of standard reduction potential ii. Purity of metal iii. Effect of moisture iv. Effect of oxygen (differential aeration principle) v. Hydrogen overvoltage, Methods of protections of metals from corrosion, Electroplating: Electrolysis, Faraday's laws, Cathode current Efficiency, Basic principles of electroplating, Cleaning of articles, Electroplating of chromium, Anodising

#### Unit IV Paper Industry (06)

Manufacturing of Pulp,Types of pulp-Sulphate and soda ,Manufacturing of paper, calendaring ,ecological problems of Indian Paper industry, Features of good paper industry



## Unit V Soaps and Detergents (07)

Introduction, Soaps - Raw materials, Types of soaps, Cleansing action of soap, Manufacture of soap - Boiled or Hot Process, Detergents - Raw Materials, Types of Detergents: Anionic, cationic and amphoteric, Preparation of Teepol and Deriphath, Comparisons between soaps and detergents.

### Reference Books:

- 1) Principles of Physical Chemistry by Puri, Sharma and Pathania, Vishal Publishing company Jalindhar
- 2) Essential of Physical Chemistry by Bahl B.S., Tuli G.D. and Bahl Arun, S.Chand and Company Ltd. New Delhi
- 3) Modern Analytical Chemistry By David Harvey, McGRAW-Hill International Edition, 2000
- 4) Industrial chemistry by B.K.Sharma, Goel Publishing Housing, 16th edition 2011
- 5) Advanced Inorganic Chemistry, Vol.No.1, by Gurudeep Raj, Krishna Prakashan Media Ltd, Goel Publication, Meerut
- 6) Analytical chemistry by B.K.Sharma, Krishna Prakashan Media Ltd, Meerut, edition 3rd 2011
- 7) Principles of electroplating and electroforming by Blum and Hogaboom
- 8) Chemical Process Industries by Shreve and Brink
- 9) Industrial Chemistry by Loutfy Madkor and Helen Njenga
- 10) Elementary Principles of Chemical Processes by Richard Felder and Ronald Rousseau, John Wiley and Sons

## B.Sc.Part II (CBCS) Sem IV

### Paper No. DSC-D3- Chemistry paper No. VII (Industrial Chemistry)

(Theory Credits: 02 : 30 hours, 38 lectures)

Expected learning Outcomes :

Name of the topic	Expected Learning Outcome
1.Co-ordination Chemistry	.Learning and Understanding basic concepts about coordination complexes
2. Chelation	Knowledge about application of chelates in analytical chemistry.
3. P- Block elements	Understanding the properties of P – block elements
4. Chemistry of elements of 3d series elements	Student will be capable of understanding the properties of 3d series elements
5 Inorganic semi-micro qualitative analysis	Student will learn the basic knowledge about the qualitative analysis of inorganic compounds

#### Unit 1: Co-ordination chemistry

(10)

- 1.1 Introduction-Definition and formation of co-ordinate covalent bond in  $\text{BF}_3 - \text{NH}_3$ ,  $[\text{NH}_4]^+$  and  $\text{H}_2\text{O}$
- 1.2 Distinguish between double salt and complex salt
- 1.3 Werner's theory-
  - 1.3.1. Postulates
  - 1.3.2. The theory as applied to cobalt amines viz.  $\text{CoCl}_3.6\text{NH}_3$ ,  $\text{CoCl}_3.5\text{NH}_3$ ,  $\text{CoCl}_3.4\text{NH}_3$ ,  $\text{CoCl}_3.3\text{NH}_3$
- 1.4 Description of the terms- ligand, co-ordination number, co-ordination sphere, Effective atomic number
- 1.5 IUPAC nomenclature of coordination compounds.
- 1.6 Isomerism in complexes with C.N. 4 and 6
  - 1.6.1 Geometrical Isomerism
  - 1.6.2 Optical Isomerism
  - 1.6.3 Structural Isomerism-Ionisation Isomerism, Hydrate Isomerism, Coordination Isomerism, Linkage Isomerism and Co-ordination position Isomerism
- 1.7 Valance bond theory of transition metal complex with respect to, C.N. 4, complexes of Cu and Ni  
C.N. 6 complexes of Fe and Co

#### Unit 2: Chelation

(05)

- 2.1 A brief introduction with respect to ligands, chelating agent, chelation and metal chelates.
- 2.2 Structural requirements of chelate formation
- 2.3 Difference between metal chelate and metal complex
- 2.4 Classification of chelating agents (with specific illustration of bidentate chelating agents)
- 2.5 Application of chelation with respect to chelating agents - EDTA and DMG

### Unit-3. P- Block elements ( Group 13, 14 and 15 )

(09)

- 3.1. Position of elements in periodic table
- 3.2. Characteristics of p-block elements with special reference to Electronic configuration and Periodic properties
- 3.3. Compounds of group 13,14 and 15
  - 3.3.1 Boron-Diborane method of preparation and nature of bonding (structure)
  - 3.3.2 Borazine method of preparation and nature of bonding (structure)
  - 3.3.3 Allotropes of carbon and phosphorus
  - 3.3.4 Oxyacids of nitrogen –  $\text{HNO}_2$ ,  $\text{HNO}_3$ .
  - 3.3.5 Hydrides of Nitrogen-  $\text{NH}_3$  and  $\text{N}_2\text{H}_4$

### Unit 4: Chemistry of elements of 3d series elements

(06)

- 4.1 Position of elements in periodic table
- 4.2 Characteristics of d-block elements with special reference to
  - i) Electronic structure
  - ii) Oxidation states, stability of oxidation states of Fe with respect to Latimer diagram
  - iii) Magnetic character
  - iv) Colored ions
  - v) Complex formation.

### Unit-5. Inorganic semi-micro qualitative analysis

(08)

- 5.1 Theoretical principles involved in qualitative analysis.
- 5.2 Applications of solubility product and common ion effect in separation of cations into groups.
- 5.3 Application of complex formation in
  - a) Separation of II group into IIA and IIB sub-groups.
  - b) Separation of Copper from Cadmium.
  - c) Separation of Cobalt from Nickel.
  - d) Separation of  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ .
  - e) Detection of  $\text{NO}_2^-$ ,  $\text{NO}_3^-$  (Brown ring test).
- 5.4 Application of oxidation and reduction in
  - a) Separation of  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$  in mixture
  - b) Separation of  $\text{NO}_2^-$  and  $\text{NO}_3^-$  in mixture.
- 5.5 Spot test analysis.

#### Reference Books :

1. Inorganic chemistry, Principles of structure and reactivity by J.E. Huheey and etal
2. Inorganic Chemistry by Shriver and Atkins 5<sup>th</sup> edition
3. Vogels text book of Qualitative Inorganic analysis by A. I. Vogel .3<sup>rd</sup> and 6<sup>th</sup> edition
4. Advanced Inorganic Chemistry by Agrawal Keemtilal (Pragati Prakashan)
- 5 Theoretical Inorganic chemistry by C.Day & J.Selbin II<sup>nd</sup> edition
6. Principles of inorganic chemistry by Puri Sharma & Kalia
7. Modern Inorganic chemistry by R.D.Madan (S.Chand)
8. Inorganic Chemistry by J.D.Lee
9. Basic Inorganic Chemistry by F.A.Cotton,G.Wilkilson & B.L.Gaus wiley
10. Chemistry for Degree students by R.L.Madan (S.Chand Publication)

## B.Sc.Part II (CBCS) Sem IV

### Paper No. DSC- D4 - Chemistry paper No. VIII (Organic Chemistry)

(Theory Credits: 02 : 30 hours, 38 lectures)

Expected learning Outcomes :

Name of the topic	Expected Learning Outcome
Carboxylic acids and their derivatives.	To impart knowledge about the synthesis, reactivity and applications of carboxylic acids.
Amines and Diazonium Salts	Knowledge about classification, preparation and applications of amines and diazonium salts.
Carbohydrates	Understanding the classification, configuration and structure of carbohydrates.
Carbonyl Compounds- Aldehydes and Ketone	Student will be capable of understanding the nomenclature and reactivity of aldehydes and ketones.
Stereochemistry	Student will learn the basic knowledge conformational analysis of organic compounds

#### Unit 1: Carboxylic acids and their derivatives.

[8L]

1.1 Monocarboxylic acid: Introduction, Methods of Formation from Alcohols, Aldehydes, Ketones, Nitriles and Alkyl benzenes.

Chemical Reaction: Hell-Vohlard-Zelinsky (HVZ) reaction.

1.2 Formation of Halo Acids, Mono, Di, Tri- chloro acetic acid.

Substitution reaction of Monochloro acetic acid by Nucleophile  $\text{OH}^-$ ,  $\text{I}^-$ ,  $\text{CN}^-$  and  $\text{NH}_3$

1.3 Hydroxy acids: Malic and Citric acid

Methods of formation of Malic acid from maleic acid, from Alpha bromo succinic acid and moist  $\text{Ag}_2\text{O}$ .

Chemical Reactions: Reactions of Malic acid- Action of heat, oxidation by  $\text{KMnO}_4$  and reduction reaction with  $\text{HI}$ .

Uses of Malic acid

Method of formation of Citric acid from glycerol.

Chemical Reactions: Reaction of citric acid: acetylation by acetic anhydride, reduction by  $\text{HI}$ , action of heat.

Uses of citric acid.

1.4 Unsaturated acid: Cinnamic acid: method of formation from benzaldehyde using diethyl malonate and by using acetic anhydride and sodium acetate.

Chemical Reactions- Bromination, Oxidation. Uses of cinnamic acid

Acrylic acid: Method of formation from acrolein and by dehydration of beta hydroxy propionic acid.

Chemical Reactions: Addition of water, Reduction by  $\text{Na}/\text{C}_2\text{H}_5\text{OH}$ . Uses of acrylic acid.

1.5 Dicarboxylic acid: Succinic and phthalic acid

Method of formation of succinic acid from ethylene dibromide, maleic acid

Chemical Reactions: Action of heat, Action of  $\text{NaHCO}_3$ ,  $\text{C}_2\text{H}_5\text{OH}$  in presence of acid.

Uses of succinic acid.

Phthalic acid: Method of formation from o-xylene and Naphthalene

Chemical Reactions: Action of heat, reaction with sodalime, ammonia, uses of phthalic acid.

1.6 Carboxylic acid derivatives: Introduction

Acid halide derivative: Acetyl chloride: formation from acid, by action with  $\text{PCl}_3$  and  $\text{SOCl}_2$ , reaction with water, alcohol (Mechanism of esterification is expected) and ammonia.

Uses of acetyl chloride.

Acid anhydride derivative: Method of formation of acetic anhydride by dehydration of acetic acid, reactions with water, alcohol and ammonia, uses of acetic anhydride.

## Unit 2: Amines and Diazonium Salts:

[8L]

2.1 Introduction, Classification, Nomenclature, structure.

2.2 Methods of preparation: a) From Alkyl halide by Amolysis, b) By Reduction of Nitriles or Cyanides, c) From Unsubstituted amides (Hoffmann degradation), d) By Gabriel Synthesis (From Phthalamide).

2.3 Reactions: Carbylamine reaction, Schotten-Baumann reaction, Electrophilic substitution (Aniline), Nitration, Bromination, Sulphonation.

2.4 Diazonium salt: Introduction, Preparation of Benzene diazonium chloride.

2.5 Reactions: Replacement by Halogen (Sandmeyer), Replacement by Iodine, Replacement by  $-\text{OH}$ , C and N Coupling reactions: Synthesis of Methyl orange and Congo red. Reduction of BDC.

## Unit 3: Carbohydrates

[8L]

Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, mutarotation and anomers.

Determination of configuration of Glucose (Fischer proof). Ring structure of glucose Determination of size of the ring of Glucose by methylation method.. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

## Unit 4: Carbonyl Compounds- Aldehydes and Ketone

[6L]

4.1 Introduction, Nomenclature, structure.

4.2 Reactivity of Carbonyl group, mechanism of Nucleophilic addition to Carbonyl group

4.3 Reactions: mechanism and application of Aldol condensation, Perkin reaction, Cannizaros reaction, Knoevenagel condensation, *Reformatsky* reaction.

## Unit 5: Stereochemistry

[8L]

5.1 Conformational isomerism – Introduction.

5.2 Representation of conformations of ethane by using Saw- Horse, Fischer (dotted line wedge) and Newmann's projection formulae.

5.3 Conformations and conformational analysis of ethane and n-butane by Newmann's Projection formula with the help of energy profile diagrams.

5.4 Cycloalkanes relative stability - Baeyer's strain theory, Theory of strainless rings.

5.5 Conformations and stability of cyclohexane and monosubstituted cyclohexanes Cyclohexanol, bromocyclohexane and methyl cyclohexane.

5.6 Locking of conformation in t-butyl cyclohexane.

## Reference Books:

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

2. Stereochemistry conformation & Mechanism, 9th Edition, By P.S.Kalasi, Publisher: New Age International, 2017

3. Stereochemistry of carbon compounds by Eliel..

4. Stereochemistry of Organic Compounds by D. Nasipuri.

5. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

6. Finar, I. L. *Organic Chemistry (Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.

7. Organic Chemistry. Volume I, II, III by S.M. Mukharjee, S.P. Singh and R.P. Kapoor. Wiley Eastern Limited (New Age International)

8. Advanced Organic Chemistry by, B.S. Bahl, ArunBahl. S.Chand & Company, Ltd.

9. Chemistry by R.L.Madan, S.Chand and Company Ltd.

**B. Sc II Practical Course**  
**Total Marks 100**  
**(Credits: 04)**

**Inorganic Chemistry (Marks 35)**

**1) Gravimetric Analysis ( Any two )**

- i) Gravimetric estimation of iron as  $\text{Fe}_2\text{O}_3$  from a solution containing Ferrous ammonium sulphate and free sulphuric acid.
- ii) Gravimetric estimation of barium as  $\text{BaSO}_4$  from a solution containing barium chloride and free hydrochloric acid.
- iii) Gravimetric estimation of nickel as  $\text{Ni}(\text{DMG})_2$  from a solution containing  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  and free sulphuric acid
- IV) Gravimetric estimation of aluminium as Aluminium oxinate from a solution containing aluminium sulphate or potash alum and free sulphuric acid.

**2) Inorganic Preparations (Any two )**

- i) Preparations of sodium cuprous thiosulphate
- ii) Preparation of tris (ethylene diamine) nickel (II) thiosulphate
- iii) Preparation of hexammine nickel (II) chloride

**3) Titrimetric Analysis ( Any four )**

(Calibration of burette, pipette and volumetric flask is essential)

- i) Fertilizer analysis : To determine percentage of nitrogen in the given sample of a nitrogenous fertilizer (ammonium sulphate). Known weight of the sample to be taken by the student. For preparing its solution which is to be refluxed with known excess of alkali. Standard HCl solution to be supplied.
- ii) Analysis of Synthetic /Commercial Sample : To estimate Magnesium from talcum powder.
- iii) Determination of total hardness of water using 0.01M EDTA solution.  
(Students should standardize the given EDTA solution by preparing 0.01M  $\text{CaCl}_2$  solution. using  $\text{CaCO}_3$  salt.)
- iv) Determination of alkali content from antacid tablet using HCl solution .
- v) Vinegar Analysis : To estimate amount of acetic acid from vinegar sample
- Vi) Estimation of Calcium from chalk : To estimate amount of calcium from the chalk by titrimetric method. ( By redox titration using  $\text{KMnO}_4$  solution )  
( Note : These experiments are performed by preparing calibrated sets of burettes, pipettes and volumetric flasks.)

**4) Semi-micro qualitative analysis**

Analysis of binary mixtures with non interfering cations and anions (at least 6 mixtures to be analyzed)

i) Following anions are to be given :

$\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{SO}_4^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{BO}_3^{3-}$  (insoluble  $\text{CO}_3^{2-}$ ,  $\text{S}^{2-}$ ,  $\text{BO}_3^{3-}$  may be given)

ii) Following cations are to be given :

$\text{Cu}^{+2}$ ,  $\text{Cd}^{2+}$

$\text{Al}^{+3}$ ,  $\text{Fe}^{+3}$ ,  $\text{Cr}^{+3}$ .

$\text{Zn}^{+2}$ ,  $\text{Mn}^{+2}$ ,  $\text{Ni}^{+2}$ ,  $\text{Co}^{+2}$ .

$\text{Ca}^{+2}$ ,  $\text{Ba}^{+2}$ .

$\text{Mg}^{+2}$ .

$\text{NH}_4^+$ ,  $\text{K}^+$

Note:-Use of spot tests to be made whenever possible.

Reference Books:

1. Vogel's text book of Qualitative Inorganic analysis by A. I. Vogel .3<sup>rd</sup> and 6<sup>th</sup> edition
2. Vogel's text book of Quantitative Inorganic Chemistry by A. I. Vogel.
3. Physical Chemistry of Inorganic qualitative analysis by Kuricose & Rajaram.
4. Practical manual in water Analysis by Goyal & Trivedi.

5. Basic Concepts in Analytical Chemistry by S. M. Khopkar. Wiley Eastern Ltd.
6. Practical Chemistry, Physical, Inorganic, Organic and Viva voce by Balwant Rai Satija. Allied Publishers Private Limited.
7. College Practical Chemistry by H. N. Patel, S. R. Jakali, H. P. Subhedar, Miss. S. P. Turakhia. Himalaya Publishing House, Mumbai.
8. College Practical Chemistry by Patel, Jakali, Mohandas, Israney, Turakhia.

### Organic Chemistry Practical's ( Marks 30)

#### A) Organic Qualitative Analysis

Identification of at least **Eight** Organic compounds with reactions including two from acids, two from phenols, two from bases and two from neutrals.

Acids – Succinic acid, Phthalic acid, Salicylic acid, Aspirin.

Phenols – Alpha-Naphthol, o-nitrophenol, p-nitrophenol.

Bases – o-,m- and p-nitroanilines, Diphenyl amine.

Neutrals – Urea, Acetanilide, Carbon tetrachloride, Bromobenzene, Methyl acetate, Nitrobenzene, Naphthalene, Anthracene, Acetophenone, Ethyl methyl ketone.

Note : A systematic study of an organic substance involves reactions in the determination of elements and functional group.

#### B) Organic Quantitative Analysis

##### I) Estimations

- 1) Estimation of ester.
- 2) Estimation of acetone.
- 3) Estimation of vitamin C.

##### II) Organic preparations

- 1) p-nitro acetanilide from acetanilide.
- 2) Acetanilide from aniline using anhydrous  $ZnCl_2$  and Zn dust.
- 3) Phthalimide from phthalic anhydride.
- 4) Benzoic acid from benzamide.

iii) **Demonstration of Thin layer chromatography.** Separation, identification and determination of  $R_f$  values

#### Reference Books :

1. Practical Organic Chemistry by A.I. Vogel.
2. Hand book of Organic qualitative analysis by H.T. Clarke.
3. A Laboratory Hand Book of Organic qualitative analysis and separation by V.S. Kulkarni. Dastane Ramchandra & Co.
4. Practical Organic Chemistry by F.G. Mann and B.C. Saunders. Low – priced Text Book. ELBS. Longman
5. Advanced Practical Organic Chemistry by N.K. Vishnoi. Vikas Publishing House Private Limited.
6. Advanced practical chemistry by J. Singh, L. D. S. Yadav, R. K. P. Singh, I. R. Siddiqui et.al, Pragati prakashan.

### Practicals Physical chemistry (Marks 25 + Journal 10 )

- 1) To study the hydrolysis of methyl acetate in presence of HCl and  $H_2SO_4$  and to determine the relative strength of acids.
- 2) To study the effect of acid strength on hydrolysis of an ester by using 0.5M HCl and 0.25M HCl.
- 3) To study the reaction between potassium persulphate and potassium iodide in solution with equal concentration of the reactants.
- 4) To study the reaction between potassium persulphate and potassium iodide in solution with unequal concentration of the reactants.
- 5) To determine the degree of dissociation and dissociation constant of acetic acid at various dilutions and to verify Ostwald's dilution law conductmetrically.
- 6) To determine the normality of the given strong acid by titrating it against the strong alkali conduct metrically.
- 7) To determine the normality of the given weak acid by titrating it against the strong alkali conductometrically.
- 8) To determine the percentage composition of a given liquid mixture by viscosity method (Density data to be given).

- 9) To determine the specific and molar refractions of benzene, toluene and xylene by Abbe's Refractometer and to determine the refraction of CH<sub>2</sub> Group (Methylene group) (Densities should be determined by students).
- 10) To determine the specific rotation and unknown concentration of sugar solution.

**Reference Books: -**

- 1) Mendham, J.Vogel's Quantitative Chemical Analysis, Pearson 2009.
- 2) Khosla,B.D.; Garg, V.C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co: New Delhi (2011).
- 3) Findlay' Practical Physical Chemistry (Longmann) 2015.
- 4) Practical Physical Chemistry: Gurtu (S. Chand) 2014.
- 5) Systematic Experimental Physical Chemistry: Rajbhoj, Chandekar (Anajali Publication) 2016.
- 6) Advanced Practical Physical Chemistry: J.B.Yadav (Goel Publishing House) 2015.

**B.Sc. II Revised Syllabus 2018-19**  
**Sem.III & IV Nature of Question paper**  
**Total Marks 50**

- Q.1 a. Answer the following in one sentence. 5**
- i)
  - ii)
  - iii)
  - IV)
  - V)
- b. Choose the correct alternative and rewrite the sentence again 5**
- I)
  - II)
  - III)
  - IV)
  - V)
- Q.2. Attempt any TWO of the following (Out of FOUR) 20**
- a)
  - b)
  - c)
  - d)
- Q.3. Answer any FOUR of the following (Out of SIX) 20**
- a)
  - b)
  - c)
  - d)



e)  
f)

# **SHIVAJI UNIVERSITY, KOLHAPUR.**



**Accredited By NAAC with 'A' Grade**

**Revised Syllabus For**

**B.Sc Part- III**

**Chemistry**

**Syllabus to be implemented from**

**June, 2020 onwards.**

## INTRODUCTION

This syllabus is prepared to give the sound knowledge and understanding of chemistry to undergraduate students at last year of the B.Sc. degree course. The goal of the syllabus is to make the study of chemistry as stimulating, interesting and relevant as possible. The syllabus is prepared by keeping in mind the aim to make students capable of studying chemistry in academic and industrial courses and to expose the students, to develop interest in them in various fields of chemistry. The new and updated syllabus is based on disciplinary approach with vigour and depth taking care the syllabus is not heavy at the same time it is comparable to the syllabi of other universities at the same level. The syllabus is prepared after discussions of number of faculty members of the subject and by considering the existing syllabi of B.Sc. Part-I, II & III, new syllabi of XI<sup>th</sup> & XII<sup>th</sup> standards, syllabi of NET and SET exams. U.G.C. model curriculum, syllabi of different entrance examination and syllabi of other Universities.

The units of the syllabus are well defined and the scope is given in detail. The periods required for units are given. The lists of reference books are given in detail.

## OBJECTIVES

1. To promote understanding of basic facts and concepts in Chemistry while retaining the excitement of Chemistry
2. To make students capable of studying Chemistry in academic and Industrial courses and to expose the students to different processes used in Industries and their applications.
3. To expose the students to various emerging new areas of Chemistry and apprise them with their prevalent in their future studies and their applications in various spheres of chemical sciences.
4. To develop problem solving skills in students.
5. To developed ability and to acquire the knowledge of terms, facts, concepts, processes, techniques and principles of subjects.
6. To develop ability to apply the knowledge of contents of principles of chemistry.
7. To inquire of new knowledge of chemistry and developments therein.
8. To expose and to develop interest in the fields of chemistry
9. To develop proper aptitude towards the subjects
10. To develop the power of appreciations, the achievements in Chemistry and role in nature and society.
11. To develop skills required in chemistry such as the proper handling of apparatus and chemicals

**Shivaji University, Kolhapur**  
**B.O.S. in Chemistry**  
**B.Sc. Part – III**  
**Semester CBCS Syllabus**  
**To be implemented from June – 2020**

**Equivalence**

<b>Sr. No.</b>	<b>Title of old paper ( Syllabus implemented from June-2015)</b>	<b>Title of new paper (To be implemented from June-2020)</b>
1	Paper – IX & XIII Physical Chemistry	Paper IX DSE-E5 and XIII DSE-F5 Inorganic Chemistry
2	Paper – X & XIV: Inorganic Chemistry	Paper- X DSE-E6 and XIV DSE-F6 Organic Chemistry
3	Paper-XI & XV: Organic Chemistry	Paper XI DSE-E7 and XV- DSE-F7 Physical Chemistry
4	Paper-XII & XVI: Analytical & Industrial Chemistry	Paper XII-DSE-E8 and XVI DSE-F8: Analytical & Industrial Chemistry

A repeater candidate, if any, will be allowed to appear for practical examination as per old course up to March / April 2021 examination.

## List of Laboratory Equipments

### Apparatus & Equipments

1. Digital balance with 1 mg accuracy
2. Conductometer
3. Potentiometer
4. pH Meter
5. Polarimeter
6. Colorimeter
7. Thermostat
8. Electric Oven
9. Suction Pump
10. Crucible Heater
11. IR Lamp
12. Magnetic stirrer
13. Buckner funnel
14. Water bath / Thermostat.
15. Platinum electrode
16. Glass electrode
17. Silver, Zinc, Copper electrodes
18. Conductivity cell
19. Distilled water plant.
20. Refractometer
21. Freeze
22. Deep Freeze
23. H<sub>2</sub>S Apparatus
24. Muffle Furnace
25. Magnetic Stirrer

### **Glassware & Porcelain ware:**

1. Burette (25/50 ml)
2. Micro burette (10 ml)
3. Pipette (5 ml,10 ml,25ml)
4. Graduated Pipette (1/2/5/10 ml)
5. Conical flask(100 ml, 250 ml)
6. Beakers (100 ml, 250 ml, 500 ml)
7. Volumetric flask (25ml,50 ml,100 ml, 250 ml)
8. Gooch Crucible / Sintered glass Crucible
9. Silica Crucible
10. Watch glass
11. Glass tubing
12. Glass Funnel (3")
13. Gas jar
14. Glass rod
15. Test Tubes (12 x100, 5x5x8)
16. Evaporating dish
17. TLC Unit
18. Measuring cylinder
19. Thiele's tubes
20. Fusion Tube
21. Capillary tube
22. Stopper bottle
23. Thermometer ( 1/10°, 360°)
24. Water condenser
25. Distillation flask (100 ml/ 250 ml )
26. Titration tiles.
27. Asbestos sheet.
28. Desiccators
29. Clay pipe triangle

**Iron & Wooden ware:**

1. Burners
2. Tripod stand
3. Iron stand
4. wire gauze
5. Burette stand
6. Test tube stand
7. Pair of tongs
8. Test tube holder
9. Spatula
10. Copper foil

**Chemicals:** All the chemicals required for experiments are mentioned in the syllabus.

**Others:**

1. Filter papers (Kalpi)
2. Whatman Filter paper No. 1, 40, 41 and 42.

## **Lab Safety Precautions / Measures in Chemistry Laboratory:**

### **Part-I: Personal Precautions**

1. All personnel must wear safety Goggles at all times.
2. Must wear the Lab. Aprons / Lab jacket and proper shoes.
3. Except in emergency, an over-hurried activity is forbidden.
4. Fume cupboard must be used whenever necessary.
5. Eating, Drinking and Smoking in the laboratories strictly forbidden.

### **Part-II: Use of safety and Emergency Equipments –**

1. First aid kits.
2. Sand Bucket.
3. Fire extinguishers (dry chemical and carbon dioxide extinguisher).
4. Chemical storage cabinet with proper ventilation.
5. Material safety data sheets
6. Management of local exhaust system and fume hoods.
7. Sign in register if using instruments.



## Nature of Theory Question Papers

N.B. The question paper should cover the entire syllabus. Marks allotted to questions should be in proportion to the lectures allotted to respective units.

**Papers Semester V:** IX-DSE-E5, X-DSE-E6, XI- DSE-E7, XII- DSE-E8,

**Semester VI:** XIII- DSE-F5, XIV-DSE-F6, XV-DSE-F7 and XVI- DSE-F8

### Total Marks 40

Question No.	Details	Marks	Marks of Options
1.	Answer in one sentence (One mark for each question).	4	-
	Multiple choice questions (One mark for each question)	4	-
2.	Long answer type questions (2 out of 3)	20	10
3.	Short answer type questions (3out of 5)	12	08
	Total	40	18

**SHIVAJI UNIVERSITY, KOLHAPUR**  
**B.O.S. in Chemistry**  
**B.Sc. Part – III**  
**Semester CBCS Syllabus**  
**To be implemented from June – 2020**

**General Structure**

**Theory Examination:**

There will be four theory papers of 40 marks each for each semester. Their titles and distribution of marks are as follows.

**Semester V : Papers IX-DSE-E5, X-DSE-E6, XI- DSE-E7, XII- DSE-E8,**

**Semester VI: Papers XIII- DSE-F5, XIV-DSE-F6, XV-DSE-F7 and XVI- DSE-F8**

Paper – **IX** DSE-E5, & **XIII** DSE-F5: Inorganic Chemistry – 40 marks

Paper – **X** DSE-E6 & **XIV** DSE-F6: Organic Chemistry – 40 marks

Paper – **XI** DSE-E7 & **XV** DSE-F7: Physical Chemistry – 40 marks

Paper – **XII** DSE-E8 & **XVI** DSE-F8: Analytical and Industrial Chemistry – 40 marks

The duration of each theory paper for examination will be of 2 hours

**Internal examination** (Oral/Seminar/test/home assignment) will be conducted for 10 marks for each paper.

**Practical Examination:**

Practical examination will be of 200 marks. The distribution of marks will be as follows:

1. Physical Section : 60 marks
2. Inorganic Section : 65 marks
3. Organic Section : 60 marks
4. Project : 15 marks

**Total: 200 marks**

The duration of practical examination will be of three days – six and half hours per day.

**CHEMISTRY**  
**Semester Syllabus for B.Sc.-III**

**Theory**

1. N. B. Figures shown in bracket indicate the total lectures required for the respective topics.
  2. The question paper should cover the entire syllabus. Marks allotted to questions should be in proportion to the lectures allotted to respective topics.
  3. All topics should be dealt with S.I. units.
  4. Study tour/industrial visit/visit to national institute or research laboratory is prescribed.
  5. Use of recent editions of reference books is essential.
  6. Use of scientific calculator is allowed.
  7. **Values required for spectral problems should be provided in the question paper.**
-

**B.Sc. Part III (CBCS) SEMESTER-V**  
**Paper No. DSE-E5, Chemistry Paper No. –IX**  
**(Inorganic Chemistry)**  
**(Theory Credits: 02, 30 hours, 37 lectures)**

**Expected Learning Outcomes:**

Name of the topic	Expected Learning Outcome
1. Acids bases and Non-aqueous solvents	Useful for the study of role of acids and bases in Chemistry. The study of non –aqueous solvents is important to learn all chemical properties of solutes and from the research point of view.
2. Metal ligand bonding in transition metal complexes	Useful to understand geometry, stability and nature of bonding between metal ion and ligand in complexes.
3. Metals, semiconductors and Superconductors	The topic deals with the synthesis and the applications of the semiconductors and Superconductors in electrical and electronic devices.
4. Organometallic compounds	The structure, method of preparation and the applications of organo metallic compound in various fields are explained.
5. Catalysis	The classification, types, mechanism and applications of catalyst in industrial fields is explained.

**Unit 1. Acids, Bases and Non aqueous Solvents**

**[8]**

1.1 Introduction to theories of Acids and Bases-Arrhenius concept, Bronsted-Lowry concept, Lewis Concept, Lux-Flood Concept (definition and examples)

1.2 Hard and Soft Acids and Bases. (HSAB Concept)

1.2.1 Classification of acids and bases as hard, soft and borderline.

1.2.2 Pearson's HSAB concept.

1.2.3 Acid–Base strength and hardness-softness.

1.2.4 Applications and limitations of HSAB principle.

1.3 Chemistry of Non aqueous Solvents.

1.3.1 Introduction, definition and characteristics of solvents.

1.3.2 Classification of solvents.

1.3.3 Physical properties and Acid-Base reactions in Liquid Ammonia (NH<sub>3</sub>) and Liquid Sulphur Dioxide (SO<sub>2</sub>).

## Unit 2. Metal Ligand bonding in Transition Metal Complexes

[10]

### 2.1 Crystal field theory (CFT)

2.1.1 Introduction: Shapes of d-orbitals, Basic assumptions of CFT.

2.1.2 Crystal field splitting of d-orbitals of metal ion in octahedral, tetrahedral, square planar complexes and John-Teller distortion.

2.1.3 Factors affecting the Crystal field splitting.

2.1.4 High spin and low spin octahedral complexes w.r.t. Co (II).

2.1.5 Crystal Field stabilization energy (CFSE), Calculation with respect to octahedral complexes only.

2.1.6 Limitations of CFT.

### 2.2 Molecular orbital theory (MOT).

2.2.1 Introduction.

2.2.2 MOT of octahedral complexes with sigma bonding such as  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ ,  $[\text{CoF}_6]^{3-}$ ,  $[\text{Co}(\text{NH}_3)_6]^{3+}$ .

2.2.3 Merits and demerits of MOT.

## Unit 3. Metals, Semiconductors and Superconductors.

[9]

3.1 Introduction.

3.2 Properties of metallic solids.

3.3 Theories of bonding in metal.

i. Free electron theory.

ii. Molecular orbital theory (Band theory).

3.4 Classification of solids as conductor, insulators and semiconductors on the basis of band theory.

3.5 Semiconductors- Types - intrinsic and extrinsic and applications of semiconductors.

3.6 Superconductors: Ceramic superconductors - Preparation and structures of mixed oxide  $\text{YBa}_2\text{Cu}_3\text{O}_{7-x}$ .

3.7 Applications of superconductors.

**Unit.4. Organometallic Chemistry.** [4]

- 4.1 Definition, Nomenclature of organometallic compounds.
- 4.2 Synthesis and structural study of alkyl and aryl compounds of Be and Al.
- 4.3 Mononuclear carbonyls -Nature of bonding in simple mononuclear carbonyls.: $[\text{Ni}(\text{CO})_4]$ ,  
 $[\text{Fe}(\text{CO})_5]$ ,  $[\text{Cr}(\text{CO})_6]$ .

**Unit 5. Catalysis** [5]

- 5.1 Introduction
- 5.2 Classification of catalytic reaction- Homogenous and Heterogeneous
- 5.3 Types of Catalysis.
- 5.4 Characteristics of catalytic reactions.
- 5.5 Mechanism of catalysis.
  - i. Intermediate compound formation theory.
  - ii. Adsorption theory.
- 5.6 Industrial applications of catalysis.

**Reference Books:**

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.
2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Langford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4<sup>th</sup> Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3<sup>rd</sup> Edition. John Wiley publication.
6. Structural principles in inorganic compounds. W. E. Addison.
7. Theoretical principles of Inorganic Chemistry – G. S. Manku.
8. Theoretical Inorganic Chemistry by Day and Selbina.
9. Co-ordination compounds. SFA Kettle.
10. Essentials of Nuclear Chemistry by H. J. Arnikar.
11. Nuclear Chemistry by M. N. Sastri.
12. Organometallic Chemistry by R. C. Mahrotra, A. Sing, Wiley Eastern Ltd. New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addison – Wesley Longman – Inc.

14. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
15. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House – New Delhi.
16. Inorganic Chemistry 3rd Edn G. L. Miessler and D.A. Tarr, pearson publication.
17. Co-ordination compounds by Baselo and Pearson.
18. UGC Inorganic chemistry by H.C. Khera, Pragati prakashan
19. UGC Advanced Inorganic Chemistry by Agarwal and Keemtilal, Pragati Prakashan

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**B.Sc. Part III (CBCS) SEMESTER-V**  
**Paper No. DSE-E6 Chemistry Paper No. X**  
**(Organic Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 lectures)**

**Expected learning Outcomes:**

<b>Name of the topic</b>	<b>Expected Learning Outcome</b>
1. Introduction to Spectroscopy	Understanding of energy associated with electromagnetic radiation and its use in analytical technique.
2. UV-Vis Spectroscopy	Knowledge of chromophore, auxochrome and calculation of $\lambda_{\max}$ .
3. IR Spectroscopy	Knowledge of vibrational transitions, regions of IR spectrum, functional group recognition.
4. NMR Spectroscopy	Understanding of magnetic-non magnetic nuclei, shielding-deshielding, chemical shift, splitting pattern
5. Mass spectroscopy.	Knowledge of molecular ion, fragmentation pattern and different types of ions produced.
6. Combined Problems based on UV-Vis, IR, NMR and Mass Spectral data	Student will predict the structure of organic compound with the help of provided spectral data.

## **Unit 1. Introduction to Spectroscopy**

**[03]**

- 1.1 Meaning of spectroscopy.
- 1.2 Nature of electromagnetic radiation: wavelength, frequency, energy, amplitude, wave number and their relationship.
- 1.3 Different units of measurement of wavelength and frequency.
- 1.4 Different regions of electromagnetic radiations.
- 1.5 Interaction of radiation with matter: absorption, emission, fluorescence and scattering.
- 1.6 Types of spectroscopy and advantages of spectroscopic methods.
- 1.7 Energy types and energy levels of atoms and molecules.

## **Unit 2. UV-Vis Spectroscopy**

**[05]**

- 2.1 Introduction.
- 2.2 Beer-Lambert's law, absorption of UV radiation by organic molecules leading to different excitations.
- 2.3 Terms used in UV Spectroscopy: Chromophore, Auxochrome, Bathochromic shift, hypsochromic shift, hyperchromic and hypochromic effect.
- 2.4 Modes of electromagnetic transitions.
- 2.5 Effect of conjugation on position of UV band.
- 2.6 Calculation of  $\lambda_{\max}$  by Woodward and Fischer rules for dienes and enones.
- 2.7 Colour and visible spectrum.
- 2.8 Applications of UV Spectroscopy.

## **Unit 3. IR Spectroscopy**

**[06]**

- 3.1 Introduction.
- 3.2 Principles of IR Spectroscopy.
- 3.3 Instrumentation, schematic diagram.
- 3.4 Fundamental modes of vibrations, types and calculation.
- 3.5 Conditions for absorption of IR radiations.
- 3.6 Regions of IR spectrum, fundamental group region, finger print region.
- 3.7 Hook's Law for Calculation of vibrational frequency.
- 3.8 Factors affecting IR absorption frequency.



3.9 Characteristic of IR absorption of following functional groups a) alkanes, alkenes, alkynes b) alcohol and phenols c) ethers d) carbonyl compounds e) amines f) nitro compounds and g) aromatic compounds.

#### **Unit 4. NMR Spectroscopy**

**[09]**

- 4.1 Introduction.
- 4.2 Principles of PMR Spectroscopy.
- 4.3 NMR- Instrumentation, Schematic diagram.
- 4.4 Magnetic and nonmagnetic nuclei.
- 4.5 Chemical shift: definition, measurement, calculation, Factors affecting Chemical shift.
- 4.6 Shielding & deshielding.
- 4.7 Peak Integration.
- 4.8 Merits of TMS as PMR reference compound.
- 4.9 Coupling Constant.
- 4.10 Types of Coupling Constant.
- 4.11 Spin-spin splitting (n+1 rule).
- 4.12 Applications.

#### **Unit 5. Mass Spectroscopy.**

**[08]**

- 5.1 Introduction.
- 5.2 Principles of mass spectroscopy.
- 5.3 Mass spectrometer - schematic diagram.
- 5.4 Types of ions produced during fragmentation.
- 5.5 Nitrogen rule
- 5.6 Fragmentation patterns of: alkanes, alkenes, aromatic hydrocarbons, alcohols, phenols, amines and carbonyl compounds.
- 5.7 McLafferty rearrangement.
- 5.8 Applications.

#### **Unit 6. Combined Problems based on UV, IR, NMR and Mass Spectral data.**

**[07]**

**Reference Books: (Use recent editions)**

1. Absorption Spectroscopy of Organic Molecules by V.M.Parikh.
2. Spectroscopy of Organic compounds by P. S. Kalsi.
3. Elementary Organic Absorption Spectroscopy by Y. R. Sharma.
4. Instrumental Methods of Analysis (7<sup>th</sup> edition) by Willard, Merritt, Dean, Settle.
5. Spectroscopy by G. R. Chatwal and S. K. Anand
6. Spectroscopy by Pavia, Lampman, Kriz, Vyvyan
7. Organic Spectroscopy (2<sup>nd</sup> edition) by Jag Mohan
8. Organic Spectroscopy (3<sup>rd</sup> edition) by William Kemp
9. Instrumental Methods of Chemical Analysis by H. Kaur

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**B.Sc.-III (CBCS) SEMESTER V**  
**Paper No. DSE- E7 Chemistry Paper No. XI**  
**(Physical Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 lectures)**

**Expected learning Outcomes:**

<b>Name of the Topics</b>	<b>Expected Learning Outcome</b>
1. Elementary quantum mechanics	Learning and understanding quantum Chemistry, Heisenberg's uncertainty principle, concept of energy operators (Hamiltonian), learning of Schrodinger wave equation. Physical interpretation of the $\psi$ and $\psi^2$ . Particle in a one dimensional box
2. Spectroscopy	Knowledge about spectroscopy, Electromagnetic spectrum, Energy level diagram, Study of rotational spectra of diatomic molecules: Rigid rotor model, Microwave oven, vibrational spectra of diatomic molecules, simple Harmonic oscillator model, Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, related knowledge will be gained by the students.
3. Photochemistry	Learning and understanding photochemical laws, reactions and various photochemical phenomena.
4. Solution	Learning the various types of solutions, relations vapour pressure, temperature relations.
5. Electromotive force	Learning and understanding the knowledge of emf measurements, types of electrodes, different types of cells, various applications of emf measurements.

## **Unit 1. Elementary quantum mechanics**

**[08]**

- 1.1 Introduction.
- 1.2 Drawbacks of classical mechanics, Black body radiation, Photoelectric effect, Compton effect, Dual nature of matter and energy: De Broglie hypothesis.
- 1.3 The Heisenberg's uncertainty principle.
- 1.4 Concept of energy operators (Hamiltonian).
- 1.5 Derivation of Schrodinger wave equation, well behaved function.
- 1.6 Physical interpretation of the  $\psi$  and  $\psi^2$ .
- 1.7 Particle in a one dimensional box.
- 1.8 Numerical problems.

## **Unit 2. Spectroscopy**

**[08]**

- 2.1 Introduction.
- 2.2 Electromagnetic radiation.
- 2.3 Interaction of radiation with matter, Electromagnetic spectrum, Energy level diagram.
- 2.4 Rotational spectra of diatomic molecules: Rigid rotor model, moment of inertia, energy levels of rigid rotor, selection rules, Intensity of spectral lines, determination of bond length, isotope effect, Microwave oven
- 2.5 Vibrational spectra of diatomic molecules: Simple Harmonic oscillator model, Vibrational energies of diatomic molecules, Determination of force constant, overtones.
- 2.6 Raman spectra: Concept of polarizability, pure rotational and pure Vibrational Raman spectra of diatomic molecules, selection rules.
- 2.7 Comparative study of IR and Raman spectra, rule of mutual exclusion-  $\text{CO}_2$  molecule.
- 2.8 Numerical problems.

## **Unit 3. Photochemistry**

**[06]**

- 3.1 Introduction, Difference between thermal and photochemical processes.
- 3.2 Laws of photochemistry: i) Grotthus - Draper law ii) Lambert law iii) Lambert – Beer's law (with derivation) iv) Stark-Einstein law.

- 3.3 Quantum yield, Reasons for high and low quantum yield.
- 3.4 Factors affecting Quantum yield.
- 3.5 Photosensitized reactions – Dissociation of H<sub>2</sub>, Photosynthesis.
- 3.6 Photodimerisation of anthracene, decomposition of HI and HBr.
- 3.7 Jablonski diagram depicting various processes occurring in the excited state:  
Qualitative description of fluorescence and phosphorescence.
- 3.8 Chemiluminescence, Electroluminescence and Bioluminescence.
- 3.9 Numerical problems.

#### **Unit 4. Solutions**

**[06]**

- 4.1 Introduction.
- 4.2 Ideal solutions, Raoult's law, Vapour pressure of ideal and non ideal solutions of miscible liquids.
- 4.3 Composition of liquid and vapour, vapour pressure and boiling point diagrams of miscible liquids. Distillation of miscible liquid pairs.  
Type I : Systems with intermediate total vapour pressure (i.e. System in which b.p. increases regularly – Zeotropic).  
Type II : Systems with a maximum in the total vapour pressure (i.e. System with a b.p. minimum – Azeotropic).  
Type III : Systems with a minimum in the total vapour pressure (i.e. System with a b.p. Maximum – Azeotropic).
- 4.4 Solubility of partially miscible liquids.
  - i. Maximum solution temperature type: Phenol – water system.
  - ii. Minimum solution temperature type: Triethyl amine – water system.
  - iii. Maximum and minimum solution temperature type: Nicotine – water system.Distillation of partially miscible liquid pairs.
- 4.5 Vapour pressure and distillation of immiscible liquids, steam distillation.

## Unit 5. Electromotive force

[10]

(Convention: Reduction potentials to be used)

- 5.1 Introduction
- 5.2 Thermodynamics of electrode potentials, Nernst equation for electrode and cell potentials in terms of activities.
- 5.3 E.M.F. series.
- 5.4 Types of electrodes: Description in terms of construction, representation, half cell reaction and emf equation for
  - i) Metal – metal ion electrode.
  - ii) Amalgam electrode.
  - iii) Metal – insoluble salt electrode.
  - iv) Gas – electrode.
  - v) Oxidation – Reduction electrode.
- 5.5 Reversible and Irreversible cells.
  - i. Chemical cells without transference.
  - ii. Concentration cells with and without transference.
  - iii. Liquid – Liquid junction potential: Origin, elimination and determination.
- 5.6 Equilibrium constant from cell emf, Determination of the thermodynamic parameters such as  $\Delta G$ ,  $\Delta H$  and  $\Delta S$ .
- 5.7 Applications of emf measurements :
  - i. Determination of pH of solution using Hydrogen electrode.
  - ii. Solubility and solubility product of sparingly soluble salts (based on concentration cells).
- 5.8 Numerical problems.

### Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.

6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons.  
Wiley International edition.
7. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania, Shobhanlal Naginchand and Company, Jalandar.
9. Instrumental methods of chemical analysis by Chatwal and Anand, 5th Edition,  
Himalaya Publication.
10. Fundamentals of molecular spectroscopy by C. N. Banwell – Tata Mc Graw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B. K. Sen, Tata Mc  
Graw -Hill.
12. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Ltd.
13. Elements of Physical Chemistry by D. Lewis and S. Glasstone (Macmillan).
14. Principles of Physical Chemistry by Maron and Lando (Amerind).
15. Electrochemistry by S. Glasstone.
16. Physical Chemistry by W. J. Moore.
17. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
18. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
19. Text Book of Physical Chemistry, Soni and Dharmarha.
20. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36<sup>th</sup> Edition

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**B.Sc. Part III (CBCS) SEMESTER-V**  
**Paper No. DSE-E8 Chemistry paper No. XII**  
**(Analytical Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 lectures)**

**Expected learning Outcomes:**

<b>Name of the topic</b>	<b>Expected Learning Outcome</b>
1.Theory of Gravimetric Analysis	Learning and understanding the techniques of gravimetric analysis.
2.Flame Photometry	Knowledge of instrumental analysis of alkali and alkaline earth elements.
3.Colorimetry and Spectrophotometry	Understanding, working and applications of optical methods as an analytical tool.
4.Potentiometric titrations	Understanding theory and applications of potentiometric titrations.
5.Chromatographic techniques and Quality control	Understanding the basics of ion exchange and column adsorption chromatography, Quality control practices in analytical industries / laboratories.

**Unit 1. Theory of Gravimetric Analysis**

**[08 ]**

- 1.1 Introduction.
- 1.2 Gravimetric analysis by precipitation: nucleation, crystal growth, digestion/ageing, filtration, drying, ignition, weighing.
- 1.3 Optimum conditions for good precipitation.
- 1.4 Physical nature of precipitate.
- 1.5 Purity of precipitate: co-precipitation, post-precipitation.
- 1.6 Organic precipitants and their applications.

**Unit 2. Flame Photometry**

**[06 ]**

- 2.1 Introduction.
- 2.2 General principles of flame photometry.
- 2.3 Instrumentation: Block diagram, Burners (Premix and Lundergraph burners), mirror, slits, filters, detector (Photomultiplier tube).
- 2.4 Effect of solvent in flame photometry.

- 2.5 Experimental procedure of analysis (Standard addition and internal standard).
- 2.6 Interferences and Factors that influence the intensity of emitted radiation in a flame photometer.
- 2.7 Applications of flame photometry in real sample analysis.
- 2.8 Limitations of flame photometry.

### **Unit 3. Colorimetry and Spectrophotometry**

**[06]**

- 3.1 Theory of colorimetry and spectrophotometry.
- 3.2 Lambert Beer's law, deviation from Beer's law.
- 3.3 Terms used in colorimetry and spectrophotometry.
- 3.4 Classification of methods of 'colour' measurement or comparison.
- 3.5 Photoelectric colorimeter method–Single beam photo-electric colorimeter.
- 3.6 Spectrophotometer method–Single beam direct reading spectrophotometer.
- 3.7 Determination of unknown concentration by using concentration-absorbance plot.
- 3.8 Applications of colorimetry and spectrophotometry.

### **Unit 4. Potentiometric titrations**

**[07]**

- 4.1 Introduction.
- 4.2 Determination of pH.
- 4.3 Study of Quinhydrone and Glass electrodes and their use in determination of pH.
- 4.4 Potentiometric titrations: Classical and analytical methods for locating end points.
- 4.5 Acids- Bases titration with suitable example.
- 4.6 Redox titration with suitable example.
- 4.7 Precipitation titration with suitable example.
- 4.8 Basic circuit of direct reading potentiometer.
- 4.9 Advantages of potentiometric titrations.

### **Unit 5. Chromatographic techniques and Quality control**

**[10]**

- 5.1 Introduction, classification.



- 5.2 **Column chromatography:** Introduction, types, Principle of adsorption column chromatography, solvent system, stationary phases, Methodology-Column packing, applications of sample, development, detection methods, recovery of components, Applications.
- 5.3 **Ion exchange chromatography:** Introduction, Principle, Types and properties of ion exchangers, Methodology-Column packing, application of sample, elution, detection/analysis, Applications.
- 5.4 **Concepts in Quality control**
- i. Introduction and Concept of quality.
  - ii. Quality control.
  - iii. Quality assurance.
  - iv. ISO series.
  - v. Good laboratory practices.

## References

1. Text Book of Quantitative inorganic analysis – A.I.Vogel.
2. Instrumental methods of chemical analysis –Willard, Merit & Dean.
3. Instrumentals methods of chemical analysis – Chatwal & Anand.
4. Vogel’s textbook of qualitative inorganic analysis – Bassett, Denny etc.
5. Textbook of qualitative inorganic analysis – Kolthoff and Sandel.
6. Fundamentals of analytical chemistry – Skoog and West.
7. Basic concepts of analytical chemistry – S.M. Khopkar.
8. Text book of qualitative chemical analysis – Vogel.
9. Handbook of quality assurance for the analytical chemistry laboratory – James P.Dux, Van Nostrand Reinhold, New York 1986.
10. Instrumental methods of chemical analysis – H.Kaur.
11. A text book of Quantitative chemical analysis Vogel’s by J.Mendham, R. C. Denney.
12. Quantitative Chemical Analysis – Daniel C. Harris.
13. Applying ISO 9000 Quality management system, International trade centre publishing genera, Indian edition printed by D. L. Shaha Trust.

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**B.Sc. Part III (CBCS) SEMESTER -VI**  
**Paper No. DSE-F5, Chemistry Paper No. –XIII**  
**(Inorganic Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 lectures)**

**Expected Learning Outcome**

Name of the topic	Expected Learning Outcome
1.Coordination Chemistry	The topic focused on the mechanism of the reactions involved in inorganic complexes of transition metals. The students can understand the thermodynamic and kinetic aspects of metal complexes.
2.Nuclear Chemistry	The generation of nuclear power with the help of nuclear reactions is highlighted. Role of radio isotopes in medicinal, industrial and Archaeology fields is explained.
3.Chemistry of f-block Elements	The characteristics, properties and separation of lanthanides and Actinides are discussed. Synthesis and IUPAC Nomenclature of trans uranic elements (TU) explained.
4.Iron and Steel	The techniques involve in ore dressing and extraction of cast iron from its ore are discussed.
5.Bio –inorganic Chemistry	Role of various metals and non metals in our health are discussed.

**Unit 1. Coordination Chemistry**

[12]

**A. Inorganic Reaction mechanism**

- 1.1 Introduction.
- 1.2 Classification of Mechanism: Association, dissociation, interchange and the rate determining steps.
- 1.3  $S_N^1$  and  $S_N^2$  reactions for inert and labile complexes.
- 1.4 Mechanism of substitution in cobalt (III) octahedral complexes.
- 1.5 Trans effect and its theories.
- 1.6 Applications of trans effect in synthesis of Pt (II) complexes.

**B. Thermodynamic and Kinetic aspects of metal complexes.**

- 1.7 Introduction.
- 1.8 Thermodynamic stability.

- 1.9 Kinetic Stability.
- 1.10 Relation between thermodynamic and kinetic stability.
- 1.11 Stepwise stability constant.
- 1.12 Factor affecting the stability of complexes.
- 1.13 Determination of Stability constant by Job variation, Mole ratio and Slope ratio method.

## **Unit 2. Nuclear Chemistry**

**[05]**

- 2.1 Nuclear reactions and energetic of nuclear reactions.
- 2.2 Types of nuclear reactions
  - i. Artificial transmutation.
  - ii. Artificial radioactivity.
  - iii. Nuclear fission and its application in heavy water nuclear reactor.
  - iv. Nuclear fusion.
- 2.3 Use of Thorium, Uranium and Plutonium in atomic energy
- 2.4 Applications of radio-isotopes as tracers.
  - i. Chemical investigation – Esterification.
  - ii. Structural determination – Phosphorus pentachloride.
  - iii. Analytical Chemistry – Isotopic dilution method for determination of volume of blood.
  - iv. Age determination – Dating by  $C^{14}$ .

## **Unit 3. Chemistry of f- Block Elements**

**[09]**

### **A | Lanthanides**

- 3.1 Introduction.
- 3.2 Occurrence.
- 3.3 Electronic Configuration.
- 3.4 Oxidation State.
- 3.5 Lanthanide contraction.
- 3.6 Separation of Lanthanides by Ion exchange method.

## **B) Actinides**

3.7 Position in periodic table.

3.8 Electronic configuration.

3.9 General methods of preparation of transuranic elements.

i. Neutron capture – followed by  $\beta$  decay.

ii. Accelerated projectile bombardment.

iii. Heavy ion bombardment.

3.10 IUPAC nomenclature of the super heavy elements with atomic number (Z) greater than 100.

## **Unit 4. Iron and Steel.**

**[07]**

4.1 Occurrence and ores of iron.

4.2 Definition of the Terms- Ore, Mineral, Slag, Flux, Gangue, Matrix, Calcinations, Reduction, Roasting, Smelting and Leaching.

4.3 Extraction of iron by Blast furnace.

4.4 Steel: Definition and types.

4.5 Conversion of cast iron into steel by

i. Bessemer process.

ii. L.D. process.

4.6 Heat treatment on steel.

## **Unit 5. Bio-inorganic Chemistry.**

**[05]**

5.1 Introduction.

5.2 Essential and trace elements in biological process.

5.3 Metalloporphyrins with special reference to hemoglobin and myoglobin.

5.4 Biological role of alkali and alkaline earth metal ions with special referenc to  $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Ca}^{2+}$

## **Reference Books: (Use recent editions)**

1. Concise Inorganic Chemistry (ELBS, 5th Edition) – J. D. Lee.

2. Inorganic Chemistry (ELBS, 3rd Edition) D. F. Shriver, P. W. Atkins, C. H. Langford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4<sup>th</sup> Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3<sup>rd</sup> Edition. John Wiley publication.
6. Structural principles in inorganic compounds. W. E. Addison.
7. Theoretical principles of Inorganic Chemistry – G. S. Manku.
8. Theoretical Inorganic Chemistry by Day and Selbine.
9. Co-ordination compounds. SFA Kettle.
10. Essentials of Nuclear Chemistry by H. J. Arnikar.
11. Nuclear Chemistry by M. N. Sastri
12. Organometallic Chemistry by R. C. Mahotra A. Sing, Wiley Eastern Ltd. New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addison – Wesley Longman – Inc.
14. Principles of Inorganic Chemistry by Puri, Sharma and Kalia, Vallabh Publication. Pitampur Delhi.
15. Text book of Inorganic Chemistry by K. N. Upadhyaya Vikas Publishing House – New Delhi.
16. Inorganic Chemistry 3rd edn G. L. Miessler and D.A. Tarr, Pearson publication
17. Co-ordination compounds by Baselo and Pearson.
18. UGC Inorganic chemistry by H.C. Khera, Pragati prakashan
19. UGC Advance Inorganic Chemistry by Agarwal and Keemtilal, Pragati Prakashan

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**B.Sc. Part III (CBCS) SEMESTER-VI**  
**Paper No. DSE-F6 Chemistry Paper No. XIV**  
**(Organic Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 Lectures)**

**Expected learning Outcomes:**

<b>Name of the topic</b>	<b>Expected Learning Outcome</b>
1. Reagents and Reactions in Organic Synthesis	Knowledge of reagents used in organic transformations and various reactions used in organic synthesis.
2. Retrosynthesis	Knowing basic terms used in retrosynthetic analysis, retrosynthesis of some organic compounds.
3. Electrophilic addition to $>C=C<$ and $-C\equiv C-$ bond	Student will learn addition reaction across $>C=C<$ bond w.r.t. hydrohalogenation, hydration hydroxylation, ozonolysis and addition of halogen, halogen acid, hydrogen, water, etc. across $-C\equiv C-$ bond.
4. Natural Products	Knowledge of terpenoids and alkaloids w.r.t. occurrence, isolation, characteristics and classification.  Analytical and synthetic evidences of Citral and Nicotine.
5. Pharmaceuticals	Understanding classification of drugs, Qualities of ideal drug. Synthesis and uses of some representative drugs and Drug action of sulpha drugs.

**Unit 1. Reagents and Reactions in Organic Synthesis**

**[10]**

**A] Reagents**

**Preparation and Applications of following reagents.**

1. Lithium aluminium hydride  $LiAlH_4$ .
2. Raney Nickel.
3. Osmium tetroxide.

4. Selenium dioxide ( $\text{SeO}_2$ ).
5. Dicyclohexyl Carbodiimide (DCC).
6. Diazomethane.

## **B] Reactions**

### **Statement, General Reaction, Mechanism and Synthetic applications**

1. Diels -Alder reaction.
2. Meerwein –Pondorff-Verley reduction.
3. Hofmann rearrangement.
4. Wittig reaction.
5. Wagner- Meerwein rearrangement.
6. Baeyer Villiger oxidation.
7. Problem based on above reactions.

## **Unit 2. Retrosynthesis**

**[06]**

- 2.1 Introduction.
- 2.2 Recapitulation of basics of reaction mechanism and reagents.
- 2.3 Terms used- Target molecule (TM), Disconnection, Synthons, Synthetic equivalence, Functional group interconversion (FGI), one group disconnection (w. r. t. suitable examples).
- 2.4 Retrosynthetic analysis and synthesis of target molecules: Cinnamaldehyde, Cyclohexene, para methoxy acetophenone, Methyl-3-phenyl propionate,  $\alpha,\alpha$ -dimethyl benzyl alcohol, Paracetamol.

## **Unit 3. Electrophilic addition to $>\text{C}=\text{C}<$ and $-\text{C}\equiv\text{C}-$ bonds [08]**

### **A. Addition to Carbon-Carbon double ( $>\text{C}=\text{C}<$ ) bond:**

- 3.1 Introduction.
- 3.2 Examples of addition reactions.
- 3.3 Mechanism of electrophilic addition to  $>\text{C}=\text{C}<$  bond, orientation & reactivity,
  - i. Hydrohalogenation.
  - ii. Anti-Markovnikoff's addition (peroxide effect).
  - iii. Rearrangements (support for formation of carbocation).

- iv. Addition of halogens.
- v. Addition of water.
- vi. Addition of hypohalous acids (HO-X).
- vii. Hydroxylation (formation of 1,2-diols).
- viii. Hydroboration-oxidation (formation of alcohol).
- ix. Hydrogenation (formation of alkane).
- x. Ozonolysis (formation of aldehydes & ketones).

**B. Addition to Carbon-Carbon triple ( $-C\equiv C-$ ) bond:**

3.4 Introduction.

3.5 Examples of addition reactions.

3.6 Mechanism of electrophilic addition to  $-C\equiv C-$  bond.

- i. Addition of halogens.
- ii. Addition of halogen acids.
- iii. Addition of hydrogen.
- iv. Addition of water.
- v. Formation of metal acetylides.

**Reference books:**

1. Organic Reactions and Their Mechanisms P. S. Kalsi 3<sup>rd</sup> Revised edition.
2. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
3. Organic Chemistry by Morrison and Boyd 6<sup>th</sup> edition.

**Unit 4. Natural Products**

[08]

**A] Terpenoids:**

- 4.1 Introduction, Occurrence, Isolation, General Characteristic, Classification.
- 4.2 General Methods for structure determinations.
- 4.3 Isoprene rule.
- 4.4 Analytical evidences and synthesis of Citral.

**B] Alkaloids:**

- 4.5 Introduction, Occurrence, Isolation, Classification, Properties.
- 4.6 General Methods for structure determination.



#### 4.7 Analytical evidences and synthesis of Nicotine.

### Unit 5. Pharmaceuticals

[06]

- 5.1 Introductio.
- 5.2 Classification.
- 5.3 Qualities of ideal drug.
- 5.4 Synthesis and uses of ethambutal, phenobarbitone, isoniazide, benzocaine, Chloramphenicol, paludrine.
- 5.5 Drug action of sulpha drugs.

### Reference books:1

1. Advanced Organic Chemistry : Reactions, Mechanisms and structure by – Jerry March.
2. Reagents for Organic Synthesis by Louis F. Fieser , Mary Fieser -1967.
3. A Text book of Practical Organic Chemistry including Qualitative Organic Analysis by A. I.Vogel.
4. Mechanism and Structure in Organic Chemistry. April,1963 By Edwin S.Gould.
5. A text book of Organic Chemistry by Arun Bahl, B.S.Bhal Eighteenth Revised edition 2006.
6. A guidebook to mechanism in Organic Chemistry sixth Edition by Peter Syke.
7. Organic Synthesis: The Disconnection Approach by Stuart Warren.
8. Organic Synthesis Through Disconnection Approach by P. S. Kalsi
9. Fundamentals of Organic Synthesis the Retrosynthetic Analysis by Ratan Kumar Kar
10. Organic Reactions and Their Mechanisms P. S. Kalsi 3<sup>rd</sup> Revised edition.
11. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
12. Organic Chemistry by Morrison and Boyd 6<sup>th</sup> edition.
13. Organic Chemistry Vol II Stereochemistry and the Chemistry of Natural Products (5<sup>th</sup> ed) by I. L.Finar.
14. Organic Chemistry Natural Products Vol I, by O. P.Agrawal
15. Industrial Chemistry-B.K. Sharma, Goyal publishing house,Mirut
16. Shreeves chemical process industries 5th Edition, G.T. Oustin, McGrawHill
17. Riegel`s hand book of Industrial chemistry, 9th Edition, Jems A.Kent
18. Industrial chemistry –R.K. Das, 2nd Edition,1976.

19. Synthetic drugs by M.S.Yadav,Campus book international.

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**B.Sc. III (CBCS) SEMESTER-VI**  
**Paper No. DSE-F 7 Chemistry Paper No. XV**  
**(Physical Chemistry)**  
**(Theory Credits: 02, 30 hours, 37 Lectures)**

**Expected Program Outcomes:**

Name of the Topics	Expected Learning Outcome
1. Phase equilibria	Learning and understanding of phase rule, learning of One component, Two component and Three component systems phase diagrams with suitable examples.
2. Thermodynamics	Knowledge about basic concept of Thermodynamics, free energy, Gibbs-Helmholtz equation and its applications, problem related with it.
3. Solid state chemistry	Learning and understanding Space lattice, lattice sites, Lattice planes, Unit cell. Laws of crystallography, Weiss indices and Miller indices, Cubic lattices and types of cubic lattice, planes or faces of a simple cubic system, Diffraction of X-rays, Derivation of Bragg's equation. Determination of crystal structure by Bragg's method. crystal structure of NaCl and KCl on the basis of Bragg's equation.
4. Chemical kinetics	Learning of kinetics, Simultaneous reactions such as i)opposing reaction ii)side reaction iii)consecutive reactions: iv) chain reaction v) explosive reaction
5. Distribution law	Learning and understanding the knowledge of distribution law, its modifications, applications of distribution laws, process of extraction, determination of solubility, distribution indicators, molecular weights.

**Unit 1. Phase Equilibria**

**[07]**

1.1 Introduction.

1.2 Gibbs phase rule : Phase rule equation and explanation of terms involved in the equation.

1.3 Phase diagram, true and metastable equilibria.

1.4 One component systems:

- i. Water system.
- ii. Sulphur system with explanation for polymorphism.

1.5 Two component systems:

- i. Eutectic system: (Ag – Pb system); Desilverisation of lead.
- ii. Freezing mixture: (KI –H<sub>2</sub>O system).
- iii. Formation of compound with congruent melting point (FeCl<sub>3</sub> – H<sub>2</sub>O).

1.6 Three component solid-liquid system:

- i. Development of triangular phase diagram: (Acetic acid – Chloroform –water system).

## **Unit 2. Thermodynamics**

**[09]**

2.1 Introduction.

2.2 Free energy: Gibbs function (G) and Helmholtz function (A), Criteria for thermodynamic equilibrium and spontaneity.

2.3 Relation between  $\Delta G$  and  $\Delta H$  : Gibbs-Helmholtz equation.

2.4 Phase equilibria : Clapeyron – Clausius equation and its applications.

2.5 Thermodynamic derivation of law of mass action, Van't – Hoff isotherm and isochore.

2.6 Fugacity and activity concepts.

2.7 Partial molar quantities, Partial molar volume, Concept of chemical potential, Gibbs-Duhem equation.

2.8 Numerical problems.

## **Unit 3. The Solid State**

**[09]**

3.1 Introduction: Space lattice, lattice sites, lattice planes, unit cell.

3.2 Laws of crystallography:

- i. Law of constancy of interfacial angles
- ii. Law of rational indices
- iii. Law of crystal symmetry.

3.3 Weiss indices and Miller indices.

- 3.4 Cubic lattice and types of cubic lattice, planes or faces of a simple cubic system, spacing of lattice planes.
- 3.5 Diffraction of X-rays, Derivation of Bragg's equation.
- 3.6 Determination of crystal structure by Bragg's method.
- 3.7 Determination of crystal structure of NaCl and KCl on the basis of Bragg's equation.
- 3.8 Numerical problems.

#### **Unit 4. Chemical Kinetics**

**[06]**

- 4.1 Introduction.
- 4.2 Simultaneous reactions such as
  - i. Opposing reaction: (Derivation of rate equation for first order opposed by first order expected).
  - ii. Side reaction.
  - iii. Consecutive reactions.
  - iv. Chain reaction.
  - v. Explosive reaction (Derivation of rate equation and Numerical problems are not expected).

#### **Unit 5. Distribution law**

**[06]**

- 5.1 Introduction, solute, solvent and solution, miscible and immiscible liquids.
- 5.2 Nernst distribution law and its limitations.
- 5.3 Modification of distribution law with respect to change in molecular state of solute (association and dissociation of solute in one of the solvent).
- 5.4 Applications of the distribution law
  - i. Process of extraction (derivation expected).
  - ii. Determination of solubility of solute in particular solvent.
  - iii. distribution indicators.
  - iv. determination of molecular weight of solute in different solvents.
- 5.5 Numerical problems.

## Reference Books:

1. Physical Chemistry by G. M. Barrow, International student Edition, Mc Graw Hill.
2. University General Chemistry by C.N.R. Rao, Macmillan.
3. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
4. The Elements of Physical Chemistry by P. W. Atkins, Oxford.
5. Principles of Physical Chemistry by S. H. Maron, C. H. Prutton, 4th Edition.
6. Nuclear and Radiochemistry by Friedlander, Kennedy and Miller, John Wiley and Sons. Wiley International edition.
7. Essentials of Nuclear Chemistry by H. J. Arnikar, 4th edition. Wiley Eastern.
8. Principles of Physical Chemistry by Puri, Sharma, Pathania, Shobhanlal Naginchand and Company, Jalandar.
9. Instrumental methods of chemical analysis by Chatwal and Anand, 5th Edition, Himalaya Publication.
10. Fundamentals of molecular spectroscopy by C. N. Banwell – Tata Mc Graw-Hill.
11. Quantum Chemistry including molecular spectroscopy by B. K. Sen, Tata Mc Graw -Hill.
12. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Ltd.
13. Elements of Physical Chemistry by D. Lewis and S. Glasstone (Macmillan).
14. Principles of Physical Chemistry by Maron and Lando (Amerind).
15. Electrochemistry by S. Glasstone.
16. Physical Chemistry by W. J. Moore.
17. Basic Chemical Thermodynamics by V. V. Rao (Macmillan).
18. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
19. Text Book of Physical Chemistry, Soni and Dharmarha.
20. Advanced Physical Chemistry Gurdeep Raj GOEL Publishing House, 36<sup>th</sup> Edition

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**B. Sc. Part III (CBCS) SEMESTER-VI**  
**Paper No. DSE-F8 Chemistry Paper No. XVI**  
**(Industrial Chemistry)**  
**(Theory Credits: 02, 30 hours, 38 lectures)**

**Expected learning Outcomes:**

<b>Name of the topic</b>	<b>Expected Learning Outcome</b>
1.Sugar Industry	Learning and understanding the whole process of manufacture of sugar and byproducts of sugar industry.
2.Manufacture of industrial heavy chemicals	Learning and understanding of physico-chemical principles of production of ammonia, sulfuric acid, nitric acid and sodium carbonate along with its manufacturing plant.
3.Synthetic polymers	Understanding and learning the classification, synthesis and applications of various polymers.
4.Petroleum industry and eco-friendly fuels	Understanding the petroleum Industry, fuels and need of use of ecofriendly fuels.
5.Nanotechnology	Understanding and learning of nanotechnology including classification, optical properties, synthesis routes, characterization techniques and applications of nano-materials.

**Unit 1. Sugar Industry**

[07]

- 1.1 Introduction.
- 1.2 Manufacture of cane sugar in India: Extraction of juice, Clarification, Concentration, crystallization, centrifugation and other details of industrial process.
- 1.3 Byproducts of sugar industry.
- 1.4 Manufacture of Ethyl Alcohol from Molasses: by Fermentation.

**Unit 2. Manufacture of Industrial Heavy Chemicals**

[08]

- 2.1 Introduction
- 2.2 Manufacture of Ammonia (NH<sub>3</sub>)
  - i. Physico-chemical principles.

ii. Manufacture by Haber's process.

### 2.3 Manufacture of Sulphuric acid ( $\text{H}_2\text{SO}_4$ )

i. Physico-chemical principles.

ii. Manufacture by Contact process.

### 2.4 Manufacture of Nitric acid ( $\text{HNO}_3$ )

i. Physico-chemical principles.

ii. Manufacture by Ostwald's process (Ammonia oxidation process).

### 2.5 Manufacture of Sodium carbonate ( $\text{Na}_2\text{CO}_3$ ) (Washing soda).

i. Physico-chemical principles.

ii. Manufacture by Solvay process.

## Unit 3. Synthetic Polymers

[08]

3.1 Introduction.

3.2 Classification.

i. Based on origin.

ii. Based on composition-organic, inorganic polymers.

iii. Based on method of preparation.

iv. Based on general physical properties.

v. Based on structure.

3.3 Addition Polymerization: Free radical addition and ionic addition polymerization.

3.4 Ziegler-Natta polymerization.

3.5 Methods of preparation and applications of some organic polymers: Polyethylene, polystyrene, polyvinyl chloride, Phenol-formaldehyde resin.

3.6 Conducting organic polymers: Synthesis and properties of Polyaniline, polypyrrole.

3.7 Applications of conducting organic polymers.

## Unit 4. Petroleum industry and eco-friendly fuels

[07]

### A] Petroleum industry

Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane

number, flash point, petroleum refineries, applications of petrochemicals, synthetic petroleum, lubricating oils & additives.

## **B| Fuels**

Fuels and eco-friendly fuels: liquid, gaseous fuel (LPG, CNG), fossil fuels, diesel, bio diesel, gasoline, aviation fuels. Use of solar energy for power generation.

## **Unit 5. Nanotechnology**

**[08]**

- 5.1 Introduction of nanotechnology, history, Classification of nanoparticles based on size.
- 5.2 Optical properties of Nanomaterial's
  - i. Semiconducting NPs.
  - ii. Metallic NPs.
- 5.3 Synthetic Routes of nanomaterials: Top-down and bottom-up approaches.
- 5.4 Synthesis methods: Sol-gel, precipitation, chemical reduction, chemical vapor deposition, hydrothermal, electrodeposition.
- 5.5 Characterization of nanomaterials: X-Ray diffractometer, Scanning Electron Microscope, Transmission electron microscope.
- 5.6 Applications of nanotechnology.

### **References:**

1. Industrial Chemistry-B.K. Sharma
2. Chemical process industries – Shrieve & Brink
3. Industrial chemistry – Kent
4. Industrial chemistry – Rogers
5. Industrial chemistry – R. K. Das
6. Mechanical chemistry – Burger
7. Nanotechnology: Principles and Practices – Sulbha Kulkarni
8. The Petroleum chemicals industry by R. F. Goldstine, e &Fn London
9. Fundamentals of petroleum chemical technology by P Below.
10. Petro Chemicals Volume 1 and 2 ; A Chauvel and Lefevrev ; Gulf Publishing company

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## **Laboratory Course (Practicals)**

**N. B.** (i) Use of Digital/Analytical/Chainometric/Single pan balance is allowed.

(ii) Use of Scientific calculator is allowed.

(iii) Use of Chart/Text book/Hand book of practical is allowed.

(iv) There will be a project having weightage of 15 marks.

Project should be in the following areas but focused on applications of Chemistry.

a) Society oriented

b) Daily use

c) Industry based

d) Analysis based

**The project will be assessed by all the three examiners with equal weightage at the time of practical examinations.**

**The project may be completed individually or by a group of students not exceeding number three.**

**One copy of the project should be submitted at the time of examination. After assessment this copy will remain in the department.**

## **INORGANIC CHEMISTRY**

### **I) Gravimetric Estimations (G).**

**N. B.** Any **two** experiments from G1 to G3 and any **two** experiment from G4 & G6.

**G1.** Gravimetric estimation of iron as ferric oxide ( $\text{Fe}_2\text{O}_3$ ) from the given solution containing ferrous ammonium sulphate, copper sulphate and free sulphuric acid.

**G2.** Gravimetric estimation of zinc as zinc pyrophosphate from the given solution

containing zinc sulphate, ferrous ammonium sulphate and free sulphuric acid.

- G3.** Gravimetric estimation of barium as barium sulphate( $\text{BaSO}_4$ ) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.
- G4.** Gravimetric estimation of barium as barium chromate( $\text{BaCrO}_4$ ) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.
- G5.** Gravimetric estimation of nickel as bis (dimethylglyoximato) nickel (II) from the given solution containing nickel sulphate, ferrous ammonium sulphate and free Sulphuric acid.
- G6.** Gravimetric estimation of aluminium as aluminium oxinate potassium tris (8-hydroxy quinolato) aluminium (III) from the given solution containing potash alum ,copper sulphate and free sulphuric acid.

[For the gravimetric experiments, stock solution should be given in the range of 10 to 15  $\text{cm}^3$  and asked to dilute to 100  $\text{cm}^3$  (or the stock solution should be given in the range of 20 to 30  $\text{cm}^3$  and asked to dilute to 250  $\text{cm}^3$ ). Use 50  $\text{cm}^3$  of this diluted solution for estimation.]

## **II. Inorganic Preparations (P).**

N. B. At least **six** preparations from the following with **percentage yield**:

- P1.** Preparation of potassium trioxalato aluminate (III).
- P2.** Preparation of Tetra ammine copper (II) chloride.
- P3.** Preparation of tris(thiourea) copper (I) sulphate.
- P4.** Preparation of potassium trioxalato ferrate (III).
- P5.** Preparation of chloropenta-ammine cobalt (III) chloride.
- P6.** Preparation of ammonium diamminetetra-thiocyanato chromate (III) (Reineck's salt).
- P7.** Preparation of Potassium hexa nitro cobaltate (III).

**P8.** Preparation of ammonium trioxalato chromate (III).

**P9.** Preparation of hexathiourea plumbus (II) nitrate.

**A) Percentage Purity**

N. B. : Any **two** from the following.

**V1.** Determination of percentage purity of ferrous ammonium sulphate.

**V2.** Determination of percentage purity of tetrammine copper (II) sulphate.

**V3.** Determination of percentage purity of potassium (trioxalato-aluminate) (III).

**B) Analysis of Commercial Sample.**

N. B. Any **Three** from the following:

**V5.** Determination of percentage of Calcium in the given sample of milk powder or lime.

**V6.** Determination of amount of aluminum in the given solution of potash alum.

**V7.** Determination of titrable acidity in the given sample of milk or lassi.

**V8.** Determination of percentage purity of boric acid using supplied sodium hydroxide.

(Standard succinic or oxalic acid solution to be prepared to standardise the given sodium hydroxide solution.)

**V9.** To determine the amount of HCl in given of commercial samples.

**C) Ion exchange method.**

N. B. Any **two** from the following.

**V10.** Determination of amount of sodium present in the given solution of common salt using cation exchange resin (By Acid Base titration).

**V11.** Determination of amount of magnesium in the given solution containing ( $Mg^{2+}$  and  $Zn^{2+}$ ) using anion exchange resin and standard solution of EDTA.

**V12.** Determination of amount of zinc in the given solution containing ( $Mg^{2+}$  and  $Zn^{2+}$ )  
using anion exchange resin and standard solution of EDTA.

**Reference Books:**

1. A text book of quantitative Inorganic Analysis - A. I. Vogel.
2. Text book of Quantitative Inorganic Analysis - Kolthoff and Sandell.
3. Experimental Inorganic Chemistry - Palmer W. G.
4. Advanced Practical Inorganic Chemistry - Adams and Raynor.
5. Manual in Dairy Chemistry - I.C.A.R. Sub-Committee on Dairy Education.
6. Chemical methods for environmental analysis - R. Ramesh and M. Anbu.

**ORGANIC CHEMISTRY**

**I) Qualitative analysis**

Separation of binary mixture and Identification of **one** component. (At least 08 mixtures)

- Nature
- 1) Solid – Solid : 4 mixtures
  - 2) Solid – Liquid : 2 mixtures
  - 3) Liquid – Liquid : 2 mixtures

1) Solid – Solid Mixtures:

**One** mixture from each the following types should be given:

- i) Acid+Phenol
- ii) Acid + Base
- iii) Acid+Neutral
- iv) Phenol +Base
- v) Phenol+Neutral
- vi) Base +Neutral

2) Solid – Liquid Mixtures

Mixture of type Neutral + Neutral or Acid + Neutral should be given.

3) Liquid – Liquid Mixtures

Mixture of type Neutral + Neutral or Base + Neutral should be

Given. Following compounds should be used for preparation of mixtures

- i) Acids: Benzoic acid, Phthalic acid, Salicylic acid, Cinnamic acid, Aspirin, Oxalic acid.
- ii) Phenols:  $\alpha$ -naphthol,  $\beta$ -naphthol.
- iii) Bases: o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, N-dimethylaniline.
- iv) Neutrals: Anthracene, acetanilide, m-dinitrobenzene, chloroform, carbon tetrachloride, acetone, nitrobenzene, ethyl acetate, ethyl benzoate, bromobenzene, urea and thiourea.

NB :

1. For Solid-Liquid and Liquid-Liquid mixtures avoid detection of type of mixture. Instead the weightage is given to detection of nature and separation of mixture.
2. Separation and qualitative analysis of the binary Mixtures should be carried out on microscale using microscale kits.

## II) Quantitative analysis: Organic Estimations:(Any four)

1. Estimation of sucrose
2. Saponification value of oil.
3. To determine the amount of acid and amide present in the given mixture of acid and amide.
4. Determination of Molecular weight of monobasic/dibasic acid by volumetric method.
5. Estimation of unsaturation –to estimate the percentage purity of given olefinic compound by bromination method.

Note: Double burette method should be used for titration.

## III) Organic Preparations: (Any four)

1. Multicomponent reaction - Preparation of Dihydropyrimidone.
2. Radical coupling reaction - Preparation of 1,1,2 bis-2naphthol.
3. Base catalyzed Aldol condensation- Preparation of Dibenzal propanone.
4. Diels Alder reaction- Reaction between Furan and Maleic acid
5. Benzil- Benzilic acid rearrangement reaction
6. Oxidation reaction – Preparation of Methyl phenyl sulfone.

#### IV) Preparation of Derivatives:

1. Picrate derivative (naphthalene and  $\alpha$ -naphthol).
2. Iodoform (Acetone).
3. Osazone of Carbohydrates (Glucose).
4. Oxalate derivative (of Urea).
5. Nitrate derivative of Urea
6. 2,4-Dinitro phenyl hydrazone (carbonyl compounds)
7. Oxime derivatives (carbonyl compounds)

**Or**

#### **Determination of structure of organic compound from given NMR spectra.**

Ethanol, Ethyl acetate, Benzyl alcohol, Propanoic acid, Butanaldehyde, Ethyl benzoate, Isopropyl benzene, Propyl ether, n-pentane, Propene, Diethyl amine, 2-chloro butane.

NB: All preparations should be carried out by considering green Chemistry approach

1. Preparation of derivative should be carried out on small scale. The starting compound should not be given more than one gram.
2. Calculation of percentage practical yield in preparation is must.
3. Recrystallization of crude product and its melting point.
4. The product should be confirmed by TLC.
5. Assign reactions with mechanism.

#### **Reference books:**

1. Practical Organic Chemistry by – A.I.Vogel.
2. Practical Organic Chemistry by – O. P.Agarwal

## PHYSICAL CHEMISTRY

### I. Non instrumental Experiments:

A. Any one of the following

**i) Partition Law.**

To determine the partition coefficient of  $\text{CH}_3\text{COOH}$  between  $\text{H}_2\text{O}$  and  $\text{CCl}_4$ .

**ii) Viscosity.**

To determine the viscosity average molecular weight of a polymer.

**iii) Adsorption.**

To investigate the adsorption of oxalic acid by activated charcoal and test the validity of Freundlich & Langmuir isotherms.

**iv) Solubility.**

To study the effect of addition of electrolyte ( $\text{NaCl}$  or  $\text{KCl}$ ) on the solubility of Benzoic acid at room temperature.

**B. Chemical kinetics. (Any four)**

1. The study of energy of activation of first order reaction i.e. hydrolysis of methyl acetate in presence of  $0.5 \text{ N HCl}$  /  $0.5 \text{ N H}_2\text{SO}_4$ .
2. The study of energy of activation of second order reaction i.e. reaction between  $\text{K}_2\text{S}_2\text{O}_8$  and  $\text{KI}$  (Equal concentrations).
3. The study of energy of activation of second order reaction i.e. reaction between  $\text{K}_2\text{S}_2\text{O}_8$  and  $\text{KI}$  (Unequal concentrations).
4. To study the hydrolysis of methyl acetate by using its two concentrations in presence of  $0.5 \text{ N HCl}$  and hence find velocity constant of the reaction.
5. To study the effect of addition of electrolyte ( $\text{KCl}$ ) on the reaction between  $\text{K}_2\text{S}_2\text{O}_8$  and  $\text{KI}$  (Equal concentrations).

**C. Partial molar volume.**

1. To determine the partial molar volume of ethyl alcohol in a mixture of ethyl alcohol and water (Any seven mixtures be given).

## II. Instrumental experiments

### A. Potentiometry (Any four)

1. Titration of strong acid with strong alkali.

**N.B. i)** 8 to 10 ml of 1N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10ml of this solution is taken for titration.

**ii)** Experiment is carried out by taking pilot run from 1 to 10 ml and then final run taking 0.2 ml reading in the range of end point.

2. Preparation of buffer solution and determination of their pH (Any five buffer solutions), Theoretical calculation of pH values by using Henderson's equation.

3. Determination of standard electrode potential of  $Zn/Zn^{++}$ ,  $Cu/Cu^{++}$ ,  $Ag/Ag^+$  (Any two).

4. Estimate the amount of  $Cl^-$ ,  $Br^-$  and  $I^-$  in given unknown halide mixture by titrating it against standard  $AgNO_3$  solution.

5. Titration of ferrous ammonium sulphate using  $K_2Cr_2O_7$  solution and to calculate redox potential of  $Fe^{++}$ ,  $Fe^{+++}$  system.

### B. Conductometry (Any three).

**N.B. i)** 8 to 10 ml of 1N acid solution to be given by examiner in 100 ml volumetric flask & student should dilute it to 100 ml and 10ml of this solution is taken for titration.

1. Titration of a mixture of weak acid and strong acid with strong alkali

2. To study the effect of substituent on dissociation constant of weak acid with respect to acetic acid and monochloroacetic acid (cell constant to be given).

**N.B.** Calculate K by using formula  $K = \frac{\alpha^2 \cdot C}{1 - \alpha}$

3. To determine the velocity constant of hydrolysis of ethyl acetate by NaOH solution by conduct metric method.

4. To determine the normality of citric acid in lemon by titrating it against standard 0.2 N NaOH solution by conduct metric method.

5. To determine  $\lambda_\infty$  of strong electrolyte (NaCl or KCl) and to verify Onsager equation.

### C. Refractometry. (Any One )

1. To determine the percentage composition of unknown mixture by (i) graphical method and (ii) by composition law (Densities of pure liquids A & B be given).

2. To determine the molar refractivity of methyl acetate, ethyl acetate, n-hexane and



carbon tetrachloride and calculate the refraction equivalents of C, H and Cl atoms.

**D. Colorimetry (Any Two).**

1. To verify Lambert – Beer’s law using  $\text{CuSO}_4$  solution.
2. To estimate of  $\text{Fe}^{+++}$  ions by thiocyanate method.
3. To estimate  $\text{Fe}^{+++}$  ions using salicylic acid by colorimetric titration.
4. To determine the order of reaction for the oxidation of alcohol by potassium dichromate and potassium permanganate in acidic medium colorimetrically.

**E. pH – metry (Any One).**

1. To determine the dissociation constant of monobasic acid (Acetic acid).
2. To determine the dissociation constant of dibasic acid (Malonic acid).
3. To determine hydrolysis constant of aniline hydrochloride.

**Reference Books:**

1. Findlay’s Practical Physical Chemistry (Longman)
2. Advanced Practical Physical Chemistry by J. B. Yadav, Goel publishing house.
3. Practical Physical Chemistry by B. D. Khosla, V. C. Garg (R. Chand and Co.)
4. Systematic experimental Physical Chemistry by Rajbhoj, Chandekar (Anjali Publicaiton) Aurangabad.
5. Practical Physical Chemistry: Nandkumari, Kothari and Lavande.
6. Practical Physical Chemistry by Gurtu (S. Chand).
7. Text Book of Qualitative Inorganic Analysis by A. I. Vogel (ELBS Longman).

**Nature of Practical Examination**

- 1) The practical examination will be of **200** marks.
- 2) The duration of practical examination will be of **three days - six and half hour per day**.
- 3) Questions related to the practical exercise/project report/industrial visit carried out by the student should be asked in viva.
- 4) Use of scientific calculator is allowed.

- 5) S.I. units should be used wherever possible.
  - 6) Use of Chart / Hand book / Text book of practical is allowed.
  - 7) A student is expected to submit a journal certified by the Head of the Department.
  - 8) A student not be permitted to appear at the practical examination unless he/she produces a certified journal. If the journal is lost, the student should produce a certificate from the Head of the Department stating that he/she has satisfactory completed the practical work but his / her journal is lost.
  - 9) Use of Digital / Analytical / Chainometric / Single pan balance is allowed.
  - 10) A student should submit one copy of project at the time of examination.**
- Each examiner should asses the project work for Five marks and sign the same. If any student will not submit project work, he/she will be given Zero mark for the project.**

11) The distribution of marks for practical examination will be as follows:

**A) Physical Chemistry 60 marks**

- i) Non-instrumental experiment 25 marks
- ii) Instrumental experiment 25 marks
- iii) Viva 05 marks
- iv) Journal 05 marks

**B) Inorganic Chemistry 65 marks**

- i) Gravimetric analysis 25 marks
- ii) Preparation 15 marks
- iii) Volumetric estimation 15 marks
- iv) Viva 05 marks
- v) Journal 05 marks

**C) Organic Chemistry 60 marks**

i) Mixture separation and identification of compounds 25 marks

ii) Estimation/Preparation 20 marks

iii) Derivative 05 marks

iv) Viva 05 marks

v) Journal 05 marks

**D) Project 15 marks**

**Total:- 200 marks**

## B.Sc. Programme structure (CBCS Pattern)

B.Sc. I, B. Sc. II, B. Sc. III Inorganic, Organic, Physical Analytical Chemistry

/ Industrial Chemistry)

### B. Sc. I

Semester	Subject	Course Code	Paper No
I	Inorganic Chemistry	DSC-3A	I
	Organic Chemistry	DSC- 4A	II
II	Physical Chemistry	DSC- 3B	III
	Analytical Chemistry	DSC – 4B	IV

### B. Sc. II

Semester	Subject	Course Code	Paper No
III	Physical Chemistry	DSC-C3	V
	Industrial Chemistry	DSC- C4	VI
IV	Inorganic Chemistry	DSC- D3	VII
	Organic Chemistry	DSC – D4	VIII

### B. Sc III

Semester	Subject	Course Code	Paper No
V	Inorganic Chemistry	DSC-E5	IX
	Organic Chemistry	DSC- E6	X
	Physical Chemistry	DSC- E7	XI
	Analytical Chemistry	DSC – E8	XII
VI	Inorganic Chemistry	DSC-F5	XIII
	Organic Chemistry	DSC- F6	XIV
	Physical Chemistry	DSC- F7	XV
	Industrial Chemistry	DSC – F8	XVI