Shivaji University, Kolhapur

B.O.S. in Chemistry

B.Sc. Part – III

Semester CBCS Syllabus

To be implemented from June - 2020

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^{th} & XII^{th} 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 appara tus and chemicals

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Equivalence

Sr. No.	Title of old paper (Syllabus implemented from June-2015)	Title of new paper (To be implemented from June-2020)
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_2S 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. Thile's tubes
20. Fusion Tube
21. Capillary tube
22. Stopper bottle
23. Thermometer ($1/10^{o}$, 360^{o})
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). Multiple choice questions (One mark for each question)	4 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

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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. Organometalic 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_3) and Liquid Sulphur Dioxide (SO_2).

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 $[Ti(H_2O)_6]^{3+}$,$[CoF_6]^{3-}$, $[Co(NH_3)_6]^{3+}$.

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 $YBa_2Cu_3O_{7-x}$.

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.:[$Ni(CO)_4$], [$Fe(CO)_5$], [$Cr(CO)_6$].

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.Lang Ford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4^{th} Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3^{rd} 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. Mahrotra, A. Sing, Wiley Eastern Ltd.New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addision – Wisley 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:

Name of the topic	Expected Learning Outcome
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 λ_{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 rul
5.6 Fragmentation patterns of: alkanes, alkenes, aromatic hydrocarbons, alcohols, phenols, amines and carbonyl compounds.
5.7 McLaffrety 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^{th} 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^{nd} edition) by JagMohan
8. Organic Spectroscopy (3^{rd} 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:

Name of the Topics	Expected Learning Outcome
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 ψ and ψ^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, Duel 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 ψ and ψ^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- 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_2, 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 ΔG, ΔH and ΔS.

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, 4thE dition.

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, 36th 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:

Name of the topic	Expected Learning Outcome
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 Lantahnide 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 β 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 Na^+, K^+ and 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.Lang Ford, Oxford University Press, 2nd Edition.
3. Basic Inorganic Chemistry : Cotton and Wilkinson.
4. Advanced Inorganic Chemistry (4^{th} Edn.) Cotton and Wilkinson.
5. Concepts and Models of Inorganic Chemistry : Douglas and Mc. Daniel. 3^{rd} 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. Mahrotra A. Sing, Wiley Eastern Ltd.New Delhi.
13. Inorganic Chemistry by A. G. Sharpe, Addision – Wisley 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:

Name of the topic	Expected Learning Outcome
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≡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≡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 tetraoxide.

4. Selenium dioxide (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, α,α-dimethyl benzyl alcohol, Paracetamol.

Unit 3. Electrophilic addition to >C=C< and −C≡C− bonds [08]

A. Addition to Carbon-Carbon double (>C=C<) bond:

3.1 Introduction.

3.2 Examples of addition reactions.

3.3 Mechanism of electrophilic addition to >C=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≡C−) bond:

3.4 Introduction.

3.5 Examples of addition reactions.

3.6 Mechanism of electrophilic addition to−C≡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 3rd Revised edition.
2. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
3. Organic Chemistry by Morrison and Boyd 6thedition.

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 3rd Revised edition.
11. Advanced organic Chemistry by B.S. Bahl & Arun Bhal (Reprint in 1997)
12. Organic Chemistry by Morrison and Boyd 6thedition.
13. Organic Chemistry Vol II Stereochemistry and the Chemistry of Natural Products (5th 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 Thermodyanamics, 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_2O system).

iii. Formation of compound with congruent melting point ($FeCl_3$ – H_2O).

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 ΔG and ΔH : 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, 4thE dition.
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, 36th 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:

Name of the topic	Expected Learning Outcome
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_3)

i. Physico-chemical principles.

ii. Manufacture by Haber's process.

2.3 Manufacture of Sulphuric acid (H_2SO_4)

i. Physico-chemical principles.

ii. Manufacture by Contact process.

2.4 Manufacture of Nitric acid (HNO_3)

i. Physico-chemical principles.

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

2.5 Manufacture of Sodium carbonate (Na_2CO_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 Zigler Nata 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, polypyrrol.

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 (Fe_2O_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($BaSO_4$) from the given solution containing barium chloride, ferric chloride and free hydrochloric acid.

G4. Gravimetric estimation of barium as barium chromate($BaCrO_4$) 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 cm^3 and asked to dilute to 100 cm^3 (or the stock solution should be given in the range of 20 to 30 cm^3 and asked to dilute to 250 cm^3). Use 50 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 diamminetetrathiocynato chromate (III) (Reineck's salt).

P7. Preparation of Potassium hexa nitro coblatate (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 sulpahte.

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+} andZn^{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 Diary 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: α-naphthol, β-naphthol.

iii) Bases:o-nitroaniline, m-nitroaniline, p-nitroaniline, aniline, o-toluidine and N, N-dimethylaniline.

iv) Neutrals: Anthracene, acetanilide, m-dintrobenzene, 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 ofmixture.
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 brominationmethod.

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 (naphathalene and α-naphthol).
2. Iodoform (Acetone).
3. Osazone of Carbohydrates (Glucose).
4. Oxalate derivative (ofUrea).
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, Butaraldehyde, 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 byTLC.
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 CH_3COOH between H_2O and 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 (NaCl or 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 N HCl / 0.5 N H_2SO_4.
2. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Equal concentrations).
3. The study of energy of activation of second order reaction i.e. reaction between $K_2S_2O_8$ and KI (Unequal concentrations).
4. To study the hydrolysis of methyl acetate by using its two concentrations in presence of 0.5 N HCl and hence find velocity constant of the reaction.
5. To study the effect of addition of electrolyte (KCl) on the reaction between $K_2S_2O_8$ and 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 $K= \alpha^2.C/1- \alpha$
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 λ_∞ 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 $CuSO_4$ solution.
2. To estimate of Fe^{+++} ions by thiocynate method.
3. To estimate 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