SAURASHTRA UNIVERSITY

SUBJECT: B. Sc. CHEMISTRY SYLLABUS

[C B C S]

Theory and Practical for

B.Sc. SEMESTER-I & II **[From June 2010]**

B.Sc. SEMESTER-III & IV **[From June 2011]**

B.Sc. SEMESTER-V & VI **[From June 2012]**

SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – I

CHEMISTRY [C-101] SYLLABUS

Unit-I : Inorganic Chemistry

1. **Periodic Properties** **[6 Hours]**
   - Explanation and General Trends of the following Periodic Properties
     (a) Atomic and Ionic Radii
     (b) Ionization Potential
     (c) Electronegativity
     (d) Electron affinity
   - Pauli's method for the determination of ionic radius of isoelectronic ions and problems based on it

2. **Bonding and Shapes of Molecules** **[6 Hours]**
   - Valence Bond Theory and its limitations
   - Hybridization – Concept of hybridization
     (a) sp {C_2H_2, $BeCl_2$}
     (b) sp^2 {BF_3, C_2H_4}
     (c) sp^3 {CH_4}
     (d) sp^3d {PCl_5}
     (e) sp^3d^2 {SF_6}
   - Stereochemistry of inorganic molecules
     (a) Sidgwick Powell Rule
     (b) VSEPR Theory

3. **Elements of the First Transition Series** **[8 Hours]**
   - Introduction and definition
   - Electronic Configuration
   - Reversal of Energies of 3d and 4s orbitals
   - **Physical Properties**
     (a) Metallic
     (b) Crystal Structure
     (c) Conductivity
     (d) Density
     (e) Catalytic Properties
     (f) Tendency of Formation of Alloys

- **Atomic Properties**
    - (a) Atomic and Ionic Radii
    - (b) Ionization Potential
    - (c) Oxidation states and their stability
- **Magnetic Properties**
    - (a) Spectral Properties
    - (b) Nonstoichiometric
    - (c) Interstitial Compounds

Unit-II: Organic Chemistry

1. Substitution and Elimination Reactions of Alkyl halides [10 Hours]

- Introduction to Types of Reactions
- Definition of Substitution and Elimination reactions
- S_N1 Reaction Mechanism
- S_N2 Reaction Mechanism
- Substitution Reactions of alkyl halide: Reaction with
    - (a) Aqueous KOH or moist Ag_2O
    - (b) Alkoxides or dry Ag_2O
    - (c) NaSH or KSH
    - (d) Na_2S or K_2S
    - (e) Alcoholic KCN
    - (f) Alcoholic NH_3
    - (g) KNO_2 or $AgNO_2$
- E^1 Reaction Mechanism
- E^2 Reaction Mechanism
- Elimination Reaction of alkyl halide
    - (a) Reaction with alcoholic KOH
    - (b) Action of heat

2. Cycloalkanes [10 Hours]

- IUPAC Nomenclature of Cycloalkanes: monocyclic, bicyclic and tricyclic systems
- Method of Preparation of small ring Cycloalkanes:
    - (a) Fund's Method
    - (b) Perkin Method
    - (c) Sabatier and Sanderson's Method
    - (d) Dieckmann Method
- Physical Properties of Cycloalkanes
- Chemical Properties of Cycloalkanes
    - (a) Substitution Reactions
    - (b) Addition Reactions

- Baeyer's Strain Theory
- Sacshe-Mohr concept of Strain less rings
- Preparation of Large ring cycloalkanes
    (a) Thorpe- Ziegler's method
    (b) Acyloin Condensation

Unit-III: Physical Chemistry

1. Thermodynamic [11 Hours]

- Definition of thermodynamics term: system, surroundings
- Types of systems
- Intensive and extensive properties
- State and path functions and their differential
- Thermodynamic processes
- Concept of heat and work.
- First Law of Thermodynamics: Statement & Mathematical form
- Definition of internal energy and enthalpy
- Calculation of w, q, ΔE & ΔH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process
- Bond dissociation energy and its calculation from thermochemical data
- Work obtained during adiabatic and isothermal change
- Heat capacity: heat capacities at constant volume and pressure and their relationship $Cp - Cv = R$
- Joule's law-joule Thomson coefficient and inversion temperature (only definition)
- Zeroth Law: mathematical treatment of Zeroth law and its limitation and various statements of law

2. Adsorption [09 Hours]

- Introduction
- Types of adsorption
- Freundlich adsorption isotherms and its limitations
- Langmuir adsorption isotherms at high & low pressure and its limitations
- Uses of adsorption

Unit-IV: Analytical Chemistry

1. Modes of Concentration [10 Hours]

[Concentration Concept with Numerical]

- Preparation of Standard Solutions
    - Equivalent weight of acid and base
    - Equivalent weight of acid salt
    - Equivalent weight of an ion

- Molarity with numerical
- Normality with numerical
- Molality with numerical
- Strength of solutions
- % concentration w/v
- Volume Fraction
- Weight Fraction

2. Acids and Bases **[10 Hours]**

- Derivation of Hydrolysis constant (kh)
- Degree of hydrolysis (h)
- pH of salt of
  - Strong acid-weak base
  - Strong base- weak acid
  - Weak acid-weak base
- Buffers solution- Buffer capacity
- Mechanism of acidic and basic buffer solution
- Derivation of equation for pH of acidic and basic buffer solution
- Numerical – Calculation of pH of buffer solutions

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – I
LABORATORY COURSE
[35 Ext.marks+15 Int. marks]
CHEMISTRY [C-102] SYLLABUS

1. **Organic Qualitative Analysis** [15 Compounds] [15 marks]
   Compounds containing one functional group such as phenolic, carboxylic acid, ester, amide, nitro, amine, aldehyde, ketone, alcohol, halogen, anilides, carbohydrate and hydrocarbon.

2. Volumetric Analysis [20 marks]

1. To prepare solution of acids and bases with definite concentration
2. To prepare a solution by dissolving 'x' gms **$NaHCO_3$ /Na_2CO_3** in 100 ml solution and determine its concentration in terms of normality and molarity using the given 0.1 M HCl solution
3. To determine the normality, molarity and gms/litre of **NaOH and HCl** using 0.05M Na_2CO_3 solution

4. To determine the molarity, g/litre and normality of each component in a given mixture of **$NaHCO_3$ and Na_2CO_3** the using 0.1 M HCl solution
5. To determine the molarity, g/litre and normality of each component in a mixture of **$H_2C_2O_4.2H_2O$ and H_2SO_4** using 0.02 M $KMnO_4$ and 0.1 M NaOH solution
6. To determine the molarity, g/litre and normality of each component in a mixture of **$H_2C_2O_4.2H_2O$ and $K_2C_2O_4.H_2O$** using 0.1 M NaOH and 0.02 M $KMnO_4$ solution
7. To determine the molarity, g/litre and normality of **$KMnO_4$ and $FeSO_4.7H_2O$** solution using 0.05 M $H_2C_2O_4.2H_2O$ solution
8. To determine the molarity, g/litre and normality of **$FeSO_4(NH_4)_2SO_4.6H_2O$** and $K_2Cr_2O_7$ solutions using 0.02 M $KMnO_4$ solution

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – II
CHEMISTRY [C-201] SYLLABUS

Unit-I: Inorganic Chemistry

1. **Ionic Solids** **[8 Hours]**
   - Introduction
   - Characteristics of ionic solids
   - Born Haber Cycle
   - Max Born Equation
   - Limiting radius ratio
   - Relation between radius ratio, coordination number and crystal structure
   - Derivation of r^+/r^- ratio in trigonal, square planar, body centred and tetrahedral crystal lattice
   - Crystal structure of ionic solids: HCP, BCP and FCC
   - Crystal structure of ionic solids
     (a) AB type - CsCl and ZnS (zinc blende)
     (b) AB_2 type - CaF_2 and TiO_2
   - Defects in Ionic Crystal Lattice (stoichiometric and nonstochiometric)
   - Semi conductors

2. **Molecular Orbital Theory** **[7 Hours]**
   - Basic Concepts of Molecular Orbital Theory

- Characteristics of molecular orbitals with necessary diagram (i.e. Bonding, anti-bonding, gerade and ungerade orbitals)
- Energy level diagram of diatomic molecules of First and Second row elements of periodic table and NO & CO molecules
- Electronic configuration of the above mentioned molecules and calculation of bond order and magnetic moment
- Comparison of MO and VB Theories

3. **Isomerism in Complexes** **[5 Hours]**
   - Introduction
   - Types of isomerism
     (a) Ionization
     (b) Polymerization
     (c) Hydration
     (d) Coordination
     (e) Position isomerism
     (f) Stereoisomerism

Unit-II: Organic Chemistry

1. Alcohols, Phenols and Ethers **[10 Hours]**

- IUPAC Nomenclature of Alcohols (Mono, di and trihydric alcohols), Phenols and Ethers
- Physical Properties of Alcohols
- Chemical Properties of Alcohols [Reactions of O-H bond cleavage and C-O bond cleavage - only reactions, no mechanisms]
- Industrial Production of Phenol
  (a) Dow Process
  (b) Cumene Process
- Physical Properties of Phenol
- Chemical Properties of Phenol
  (a) Reactions of O-H group
  (b) Reactions of aromatic ring [Electrophilic substitution reactions, Reimer Tiemann Reaction, Kolbe Schmitt Reaction, Fries Rearrangement – with reaction mechanism]
- Relative acidity of Alcohols and Phenols
- Preparation of Ethers – Williamson Synthesis
- Physical Properties of Ethers
- Chemical Properties of Ethers

(a) Substitution Reaction [Reaction with Cl_2 in dark & Reaction of Cl_2 in light]
(b) Reactions involving C-O bond cleavage [hydrolysis, reaction with H_2SO_4, cold HI and hot HI]

2. Amines [10 Hours]

- Classification and Nomenclature
- Basicity of Amines
- Physical Properties of Amines
- Preparation of Primary amines [Reduction of nitro compounds, reaction of organic halides with ammonia, Hoffmann degradation of amides]
- Chemical Properties of Primary amines [Reaction with acid chlorides, aryl sulphonyl chlorides, reaction with alkyl halides]
- Chemical Properties of Aniline [Reactions of Aniline with acid chlorides, aryl sulphonyl chlorides, Reaction with bromine (formation of 2,4,6 –tri bromo aniline and p- bromo aniline)
- Diazotization of Aniline and reactions of Diazonium salt
- Hinesburg Reaction to distinguish between Primary, Secondary and Tertiary amines

Unit-III: Physical Chemistry

1. Electromotive Force [10 Hours]

- Introduction
- Types of Cell
- Half-cell
- Reversible and irreversible cell
- Convention sign
- Types of Electrodes
- Standard Electrode Potential
- Electrolytic Cell
- Galvanic Cell
- Emf series
- Representation of Cell
- Relation between G, H and K
- Nernst Equation and its applications

2. Photochemistry [07 Hours]

(g) Laws of Photochemistry: Grothus- Drapper law; Lambert-Beers law; Stark-Einstein's law (i.e. law of photochemical equivalence)
(h) Quantum efficiency and Factors affecting quantum efficiency

(i) Reasons for low and high quantum yield
(j) Photo sensitization
(k) Fluorescence
(l) Phosphorescence
(m) Chemiluminescence

3. Catalysis [03 Hours]

- Introduction
- Types of Catalyst
- Functions
- Theories
- Acid base Catalyst
- Enzyme Catalyst
- Applications

Unit-IV: Analytical Chemistry

1. Basic Principles of Qualitative Analysis [10 Hours]

- Introduction
- Factors affecting qualitative analysis: common ion effect, solubility product (ksp)
- Use of NH_4Cl and NH_4OH in Qualitative Analysis
- Use of HCl and H_2S in Qualitative Analysis
- Numerical on common ion effect and ksp
- Necessary explanation with chemical equations in
  (a) Charcoal test
  (b) Cobalt nitrate test
  (c) Borax bead test
  (d) Flame test.

2. Water Analysis [10 Hours]

- Analysis of hardness of water in terms of
  (a) Total solid and volatile solid
  (b) Non-filterable solid and non-filterable volatile solid
  (c) Filterable solid
  (d) Total solid
  (e) Total Suspended Solid
  (f) Acidity
  (g) Basicity or Alkalinity
  (h) Turbidity

- Various method of determination of Hardness of Water

SAURASHTRA UNIVERSITY
B. Sc. SEMESTER – II
LABORATORY COURSE

CHEMISTRY PRACTICALS [C-202] SYLLABUS

1. **Qualitative Analysis of Inorganic Salts** (15 salts - 2 radicals)
   Inorganic salts containing chlorides, bromides iodides, nitrates, nitrites, sulphates, sulphites, sulphides, carbonates phosphates, oxides, chromates, and dichromates as an anion.

2. **Inorganic Volumetric Analysis: (Standard Solutions should be given)**
   1. Estimation of the amount of Cu^{2+} in the given $CuCl_2.2H_2O$solution using 0.01 M EDTA solution
   2. Estimation of the amount of Ni^{2+} in the given $NiSO_4.7H_2O$solution using 0.01 M EDTA solution
   3. Estimation of the amount of Zn^{2+} in the given $ZnCl_2$ solution using 0.01 M EDTA solution
   4. Estimation of total hardness of water by EDTA
   5. Determination of acetic acid in commercial vinegar using 0.1 M NaOH
   6. Determination of alkali in antacid using 0.1 M HCl
   7. Estimation of ferric by dichromate method (Internal indicator method)

List of Reference Books for B.Sc. Chemistry Semester I & II

List of Reference Books Inorganic Chemistry

- Concise Inorganic Chemistry by J. D. Lee, ELBS.
- Basic Inorganic Chemistry by - FA. Cotton and G. Wilkinson
- Advanced Inorganic Chemistry (3^{rd} Edition) - FA. Cotton and G. Wilkinson; Wiley Eastern Pvt. Ltd.
- Valence and Molecular Structure by Cartmell and Fowels.
- Atomic Structure and Chemical Bonding by Manas Chanda.
- Inorganic Chemistry by Suretker Thate
- Inorganic Chemistry - James E. Huheey (3^{rd} Edition) Harper International SI Edition

- Coordination Chemistry - Gurdeep Chatwal and M.S Yadav, Himalaya Publishing House
- Principles of Inorganic Chemistry- B.R. Puri, L.R. Sharma & K.C Kalia; Vallabh Publications, Delhi
- Modern Aspects of Inorganic Chemistry - H.J. Emeleus and A.G. Sharpe; Routledge & Kegan Paul Ltd., 39 Store street, London WCIE7DD
- Magneto Chemistry by Shyamal & Datta

List of Reference Books for Organic Chemistry

- Advanced Organic Chemistry by Arun Bahl and B.S.Bahl
- Text Book of Organic Chemistry for BSc students by B.S. Bahl
- A Textbook of Organic Chemistry by K.S. Tewari, N.K.Vishnoi and S.N. Mehrotra
- Organic Chemistry (Volume I, II & III) S.M. Mukherji, S.P. Singh and R.P. Kapoor
- Organic Chemistry by Morrison and Boyd
- Organic Chemistry by T.W. Graham Solomons and Craig B. Fryhle
- Organic Chemistry By Francis A. Carey
- Organic Chemistry by Clayden
- Fundamentals of Organic Chemistry by Solomon, John Wiley.
- Textbook of Organic Chemistry by P.L. Soni and H.M. Chawla
- March's Advanced Organic Chemistry Reactions, Mechanism and Structure by Michael B Smith and Jerry March
- Reaction Mechanisms and Reagents in Organic Chemistry by Gurudeep R. Chatwal
- Advanced Organic Reaction Mechanism by N. Tewari
- Organic Chemistry by I.L.Finar

List of Reference Books for Physical Chemistry

- A Textbook of Physical Chemistry by P. L. Soni, O.P. Dharmarha and U.N. Dash.
- Physical Chemistry by Dr. D. R. Pandit, A. R. Rao and Padke.
- Progressive Physical Chemistry by Dr. Snehi, Merrut Publications.
- Principles of Physical Chemistry by Puri, Sharma, Pathania.
- A text book of Physical Chemistry by Samuel Glasstone
- Elements of Physical Chemistry by Samuel Glasstone and D lewis
- Thermodynamics for Chemists by Samuel Glasstone
- Introduction to Electrochemistry by S. Gladstone
- A text book of Physical Chemistry by B.K. Sharma
- Emf by B.K. Sharma
- Principles of Physical Chemistry by S.H Maron and C.F Prutton

- Elements of Physical Chemistry by B.R Puri, L.R Sharma, M.S Pathania
- Advanced Physical Chemistry by J.N Gurtu
- Physical Chemistry by N Kundu and S.K Jain
- Physical Chemistry by KL Kapoor
- Thermodynamics by Gurudeeep Raj
- Comprehensive Physical Chemistry by Hemand Snehi
- Introduction to Physical Chemistry by Madan and Madan

List of Reference Books for Reference Books for Analytical Chemistry

- Fundamental of analytical chemistry by Skoog & West
- Instrumental Method & Chemical Analysis by B.K. Sharma
- Water Analysis and Water pollution by V.P. Kudesia
- Instrumental Method & Chemical Analysis by Chatwal Anand
- Book for Water Analysis by R. K. Trivedi, V. P. Kudesia
- Analytical Chemistry by Dick
- Inorganic Qualitative Analysis by Vogel and Gehani Parekh
- Electrometric Methods of Analysis by Browning
- Principle of Instrumental Analysis by Skoog

SAURASHTRA UNIVERSITY
B. Sc. SEMESTER – III
CHEMISTRY [C-301] SYLLABUS

Unit-I: Inorganic Chemistry

1. Wave Mechanics. [10 Hours]

- Introduction of wave Mechanics.
- Postulates of wave Mechanics.
- Interpretation of ψ, ψ^2, $\psi\ \psi^*$.
- Derivation of Schrodinger's equation in three dimensions (Cartesian Coordination).
- Eigen function & Eigen value.
- Orthogonal & Normalized wave function and problems on it.

2. Chemistry of Lanthanide Elements. [10 Hours]

- Introduction.
- Occurrence & Important ores.
- Isolation of Lanthanide Elements from ore.
- Individual Isolation by (I) Ion Exchange Method (II) Solvent Extraction Method.
- Electronics Configuration with necessary Explanation.

- Oxidation State & their Stability.
- Magnetic properties.
- Color (spectral) properties.
- Lanthanide Contraction.
- Misch Metal.
- Uses of Lanthanides & their Compounds.

Unit-II: Organic Chemistry

1. Aldehydes and Ketones [10Hours]

(A) IUPAC Nomenclature of Aldehydes and Ketones

(B) Synthesis of Aldehydes

- Oxidation of Primary Alcohols
- Rosenmund Reduction
- Gattermann Koch reaction

(C) Physical Properties of Aldehydes

(D) Chemical Properties of Aldehydes (with reaction mechanism)

Nucleophilic addition to >C=O group

- Reaction with HCN
- Reaction with ROH
- Aldol Condensation
- Crossed Aldol Condensation
- Benzoin Condensation
- Perkin Reaction

(E) Synthesis of Ketones

- Oxidation of Secondary Alcohols
- Addition of Organometallic reagents to acid or acid chloride

(F) Physical Properties of Ketones

(G) Chemical Properties of Ketones (reaction mechanism)

Nucleophilic addition to >C=O group

- Reaction with HCN
- Reaction with ROH
- Knoevenagel Condensation
- Witting reaction
- Meerwein Ponndroff-Verley Reduction
- Wolff Kishner Reduction
- Baeyer Villiger Reaction

2. Carboxylic Acid and its derivatives [10 Hours]

(A) Nomenclature of mono and dicarboxylic acids

(B) Synthesis of monocarboxylic acids

- Oxidation of Primary alcohols
- Hydrolysis of acid derivatives

(C) Physical Properties of mono carboxylic acids

(D) Acidity of Carboxylic acids
(E) Effect of substitution on Acidity of carboxylic acids
(F) Chemical Properties of mono carboxylic acids
- Salt formation
- Decarboxylation
- Halogenations-Hell Volhard Zelinsky Reaction
- Formation of acid derivatives-acid chloride , anhydrides, amides, esters

(G) Reaction of acid Derivatives
(H) Mechanism of Esterification
(I) Hydrolysis of Esters ($B_{AC}2$ Mechanism)
(J) Trans- esterification

Unit-III: Physical Chemistry

1. Basic of some physical properties [09 Hours]

- Introduction
- Surface tension and parachor (Drop method) & its method for determination
- Viscosity and its method for determination
- Refractive index and its method for determination
- Theory of Optical activity
- Dipole moment and its method for determination
- Application and numericals
- Examples

2. Phase Rule and related theory of solutions [11 Hours]

- Statement and meaning of the term – Phase, Components, Degree of freedom
- Explanation of phase equilibrium of one component system – Water & Sulphur system
- Phase equilibria of two component system : Solid-liquid mixture – desilverization of lead (Pb-Ag)
- Solid solution – compound formation with congruent melting point (Mg-Zn)
- System of $CuSO_4.5H_2O$
- Theory of liquid-liquid mixture
- Ideal liquid mixture
- Azeotropes
- Lower and upper consolute temperature
- Steam distillation
- Short explanation of Raoult's law, Henry's law & Nernst's distribution law
- Examples

Unit-IV: Industrial Chemistry [12 Hours]

1. Fuels

- Introduction
- Calorific value
- Determination of calorific value- bomb clorimeter
- Characteristic of an idea fuel
- Classification of fuels
- Natural solid fuels-wood, peat, lignite and coal
- Types of coal
- Artificial solid Fuels Charcoal, cock, and briquettes
- High and low Carbonisation of Coal
- Natural gaseous fuels – natural gas and biogas
- Artificial gaseous fuels – coal gas, water gas, oil gas, Produces gas
- Advantages and dis advantages of solid liquid and gaseous fuels

2. Synthetic drugs and dyes [08 Hours]

❖ **Drugs**

- Introduction
- Classification
- Synthesis and uses of sulpha trizole (cibazole) , phenacetin, paludrine, chloramphenicol, veronal

❖ **Dyes**

- Introduction
- Classification
- Synthesis and uses of methylorange, Diamondblack –F, malachite green, Indigotin
  Congored, Crystal violet, Alizarin

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – III
LABORATORY COURSE

CHEMISTRY PRACTICALS [C-301] SYLLABUS

1. Organic Qualitative Analysis [10 marks]

[Minimum six bifunctional Organic Compounds should be given]

Identification of an organic compound through the functional group analysis and determination of melting point or boiling point

(Bifunctional organic compounds)

2. Organic Volumetric Estimation: **[10 marks]**

[Standard solution to be given]

1. To determine the amount of $-CONH_2$ in the given Acetamide solution
2. To determine the amount of Phenol / m-cresol in the given solution
3. To determine the amount of Aniline / p-toludine in the given solution
4. To determine the amount of Ester in the given solution
5. To determine the amount of Glucose in the given solution
6. To determine the amount of –COOH in the given carboxylic acid

3. Gravimetric Estimation (Any Three) **[15 marks]**

1. Estimation of Ba as $BaSO_4$
2. Estimation of Fe as Fe_2O_3
3. Estimation of Ni as $Ni(DMG)_2$
4. Estimation of Al as Al_2O_3

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – IV
CHEMISTRY [C-401] SYLLABUS

Unit-I : Inorganic Chemistry

1. Molecular Orbital Theory. **[10 Hours]**

- Concept of Molecular Orbital Theory.
- Characteristic of Molecular Orbital.
- Wave function of H_2^+ & H_2.
- Potential energy and Schrodinger's equation for H_2^+ & H_2.
- Derivation of normalized wave function of H_2^+ based on M.O.T.
- Hybridization ; Derivation co efficient of wave function of Sp, Sp^2 & Sp^3 Hybridisation.

2. Organic Metalic Compounds. **[10 Hours]**

- Introduction.
- Classification based on nature of M-C Bond.
- Preparation, Properties and uses of Organo Lithium compounds
- Preparation of Organo Beryllium, Organo Aluminium and Zeise Salts.
- Structure of

(1) Tri Methyl aluminium (Dimer).

(2) Zeise Salt [$PtCl_2$-C_2H_4].

(3) Ferrocene.

Unit-II: Organic Chemistry

1. Hetrocyclic Compounds [10 Hours]

(a) Structure and Aromaticity of Furan, Thiophene and pyrrole

(b) Preparation of Furan, Thiophene and pyrrole

(c) Chemical Properties of Fuan, Thiophene and pyrrole

- Nitration
- Sulphonation
- Acetylation
- Chlorination
- Reaction with Organometallic Compounds

(d) Structure and Aromaticity of Pyridine

(e) Basicity of Pyridine

(f) Relative basicity of Pyridine, Pyrrole and Aliphatic amines

(g) Preparation of Pyridine from acetylene, Hantzsch's method

(h) Chemical Properties of Pyridine

- Electrophilic Substitution Reaction
- Nucleophilic Substitution Reaction

2. Active Methylene Compounds [10 Hours]

(a) Definition

(b) Keto-enol Tautomerism in Ethyl acetoacetate

(c) Proof for structure of Ethyl acetoacetate [Frankland – Duppa Stucture & Geuther Structure]

(d) Proof for structure of Ethyl acetoacetate [Claisen Condensation with reaction mechanism]

(e) Physical Properties of Ethyl acetoacetate

(f) Chemical Properties of Ethyl acetoacetate

Synthesis from Ethyl acetoacetate

- Monocarboxylic acid : Butric acid and Valeric acid
- Ketone : 2-Pentanone and 3-Methyl- 2-pentanone
- ά, β – unsaturated acid: Crotonic acid
- Dicarboxylic acid : Adipic acid
- Diketone : Acetyl acetone and Acetonyl acetone,
- Keto acid : Levulenic acid
- Hetrocyclic Compounds : 4- methyl uracil and 2,5-dimethyl pyrrole]

Unit-III: Physical Chemistry

1. Chemical kinetics [10 Hours]

- Introduction

- Order and molecularity of a reaction
- Zero order reaction
- First order reaction & it's characteristics
- Second order reaction & it's characteristics
- Third order reaction & it's characteristics
- Pseudo unimolecular reaction
- Method for determining the order of reaction. (I) Graphical method (II) Ostwald's isolation method (III) Method of half-life period (V) Integration method
- Theories of reaction rates. (I) Collision theory (II) The transition state theory
- Influence of temperature on reaction rates
- Energy of activation
- Examples

2. **The colloidal state** **[10 Hours]**
   - Introduction
   - Classification of colloidal solutions
   - Characteristics of hydrophilic and hydrophobic sols
   - Preparation of colloidal solution : Lyophilic & Lyophobic solution
   - Preparation methods: (I) Condensation methods such as by Double decomposition, Hydrolysis, Reduction, Oxidation, Exchange of solvent, controlled condensation, change of physical state in short. (II) Dispersion methods such as Bredig's method, by Grinding, Peptization in short.
   - Purification of colloidal solution : (I) Dialysis (II) Ultrafiltration (III) Ultra centrifuging
   - Properties of colloidal solutions: (I) Optical properties such as Tyndall effect, Brownian effect, Color (II) Electrical properties such as Electrical Charge, Electrical double layer & Zeta potential, Cataphoresis, Electro-osmosis.
   - The Protective colloid (gold number)
   - Application of colloidal state in short.

Unit-IV: Industrial Chemistry

1. Ceramics and Refectories **[09 Hours]**
   - Introduction to Ceramics
   - Raw materials
   - Classification based on reduction in Porosity
   - Manufacturing
   - Body Preparation using clay slip
   - Introduction to Refractories
   - Classification of Refractories

- Properties of Refractories
- Manufacturing
- Fire Clay Bricks, manufacture, Properties and uses

2. Synthetic Polymers [11 HOURS]

- Introduction
- Classification of Polymers.
- Classification of Polymers when based upon Intermolecular interaction
- Classification of Polymers based upon Structure
- Type of Polymerization reaction
- Addition Polymerization
- Free Radical Polymerization
- Ionic Polymerization
- Ziegler- Natta Polymerization
- Stereo Chemistry of Polymer Plastic
- Types of Plastics, Thermo Plastic. Thermosetting Plastic
- Synthesis of Bakelite, Teflon, melamine, Phenol formaldehyde Poly chloroprene

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – IV
LABORATORY COURSE

CHEMISTRY PRACTICALS [C-401] SYLLABUS

1. Inorganic Qualitative Analysis: **[20 Marks]**

[Minimum ten Inorganic mixtures should be given]

Qualitative Analysis of an inorganic mixture containing four radicals, excluding PO_4^{-3}, CrO_4^{-2}, $Cr_2O_7^{-2}$, AsO_3^{-3}, AsO_4^{-3}, BO_3^{-3} and S^{-2}

2. **Physicochemical Exercise [15 Marks]**

1. To determine the specific reaction rate of the hydrolysis of methyl acetate / Ethyl acetate catalyzed by H^+ ion at room temperature.
2. To study the rate of reaction between $K_2S_2O_8$ and KI.
3. To study the rate of reaction between $KBrO_3$ and KI.
4. To determine the relative strength of HCl and H_2SO_4.
5. To determine the temperature coefficient and Energy of activation for the hydrolysis of ester at two different temperatures.
6. To determine the temperature coefficient and Energy of activation for the reaction between $K_2S_2O_8$ and KI at two different temperatures

7. To determine the rate of adsorption of the given organic acid using animal charcoal.
8. Distribution Law: To study the partition co-efficient of benzoic acid between water and benzene / kerosene and hence study the molecular condition of benzoic acid in the solution.
9. To study the partition co-efficient of acetic acid between water and chloroform and hence study the molecular condition of acetic acid in the solution.
10.

List of Reference Books for B.Sc. Chemistry Semester III & IV

List of Reference Books Inorganic Chemistry

1. Valency & Molecular Structure by Cartmell-Fowles.
2. Atomic Structure & Chemical Bonding – Manas Chanda.
3. Advance Inorganic Chemistry by : Cotton Wilkinson.
4. Inorganic Chemistry by : P. L. Soni.
5. Progressive Inorganic Chemistry by : Suratker thatte.
6. Consise Inorganic Chemistry by : J. D. Lee.

List of Reference Books for Organic Chemistry

1.Advanced Organic Chemistry by Arun Bahl and B.S.Bahl
2.Text Book of Organic Chemistry for BSc students by B.S. Bahl
3. Organic Chemistry by Morrison and Boyd
4. Fundamentals of Organic Chemistry by Solomon, John Wiley.
5. Textbook of Organic Chemistry by P.L. Soni and H.M. Chawla
6. March's Advanced Organic Chemistry Reactions, Mechanism and Structure by Michael B Smith and Jerry March
7. Reaction Mechanisms and Reagents in Organic Chemistry by Gurudeep R. Chatwal
8. Advanced Organic Reaction Mechanism by N. Tewari
9. Organic Chemistry by I.L.Finar

List of Reference Books for Physical Chemistry

1. A Textbook of physical chemistry K.K. Sharma, L.K. Sharma
2. Physical Chemistry by Dr.D.R. Pandit, A.R. Rao and Padke
3. A Textbook of physical chemistry by Samuel Glasstone
4. A Textbook of physical chemistry by B.K. Sharma

List of Reference Books for Industrial Chemistry

1. Industrial instrumentation by Eckman . Donald P.
2. Shreeve's Chemical Process by Austin George
3. Fuel and combustion by by Sarkar & Samir
4. Inadustrial Chemistry by B. K. Sharma.

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – V
CHEMISTRY [C-501] SYLLABUS
INORGANIC CHEMISTRY & INDUSTRIAL CHEMISTRY

Unit-I: Inorganic Chemistry [40 Marks]

1. Wave Mechanics [17 Hours]

- Outline of basic concepts of wave mechanics(Sem-III)
- Operators algebra (addition, subtraction, multiplication), commutative property, linear operator, commutation operator, the operator DEL & DEL SQUERED, momentum operator, Hamiltonian operator
- Particle in one dimensional box; normalized wave equation and energy related to a particle moving in one dimensional box, energy levels and interpretation of energy equation, linear polymers as one dimensional box, examples.
- Particle in three dimensional box : Derivation of normalized wave equation, energy related with it, energy levels and degeneracy, examples.
- Wave equation for hydrogen atom: To derive the relation between Cartesian and polar coordinates, derivation of volume element in polar coordinates, Schrodinger equation in polar coordinates, separation of variables.
- Energy of 1s orbital, normalization condition and problems on it(in polar coordinates.

2. Crystal Field Theory-1 [12 Hours]

- Introduction
- Concept of crystal field theory
- Splitting of d-orbitals in octahedral and tetrahedral crystal field with CFSE concept.
- Factors affecting splitting energy.
- Weak field and strong field ligands.
- High spin and low spin complexes with pairing energy.
- Magnetic behaviour of transition metal complexes.
- Orbital angular momentum contribution to magnetic momentum of complexes.
- Examples based on CFSE, Pairing energy and magnetic momentum.

3. Transition metal complexes of π - acid ligands [11 Hours]

- Metal carbonyls: Definition, preparation, physical and chemical properties, nature of M-CO linear bond based on M.O. Theory with

spectral support, classification of metal carbonyls, types of CO groups and detection of CO groups using IR spectra.

- Structure of $Ni(CO)_4$,$Fe(CO)_5$,$Fe_2(CO)_9$,$Co_2(CO)_8$,$Fe_3(CO)_{12}$ and $Mn_2(CO)_{10}$
- Metal nitrosyls.

List of Reference Books (Inorganic Chemistry) :

(1) Quantum Chemistry – R.K. Prasad, New Age International Publishers
(2) Inorganic Chemistry- James E Huheey (3rd Edition) Harper International SI Edition
(3) Coordination chemistry – Gurdeep Chatwal and MS Yadav, Himalaya publishing House
(4) Principles of Inorganic Chemistry – B.R.Puri, L.R. Sharma & K.C. Kalia; Vallabh Publications, Delhi
(5) Modern aspects of Inorganic Chemitry- H.J. Emeleus and A.G. Sharpe; Routledge & Kegan Paul Ltd., 39 Store street, London WCIE7DD
(6) Advance Inorganic Chemistry (3rd Edition)- F.A. Cotton and G. Wilkinson; Wiley Eastern Pvt. Ltd.

Unit-II: Industrial Chemistry [35 Marks]

1. Cement [10 Hours]

- Introduction
- Type of cement
- Raw material for manufacture
- Cement rock benefication
- Manufacturing Processes
- (a) Dry Process (b) Wet Process
- Setting of cement
- (a) Hydrolysis (b) Hydration
- Properties of cement
- Testing of cement
- Indian Standard Institute (ISI) specification of cement
- Mortar, concrete and RCC
- Curing and decay of concrete
- Uses of cement

2. Fertilisers [15 Hours]

- Introduction
- Plant nutrients and its role

- Classification of fertilisers
- Properties of fertilisers
- Nitrogenous fertilisers
- Ammonium nitrate
  (a) Manufacture by Prilling method
  (b) Manufacture by Stengel method
- Ammonium sulphate
  (a) Manufacture from gypsum (Sindri Process)
  (b) Action as fertiliser
- Urea
  (a) Manufacture from ammonium carbamate
  (b) Action as fertiliser
- Calcium cyanamide
  (a) Manufacture by electric carbonate
  (b) Action as fertiliser
- Phosphate fertiliser
- Normal super phosphate
- Manufacture
- Triple super phosphate
- Manufacture
- Ammonium Phosphate

(a) Manufacture of mono ammonium phosphate
(b) Manufacture of diammonium phosphate

- Potassium fertiliser
- NPK fertiliser
- Nomenclature

3. Petrochemicals [10 Hours]

- Introduction
- Petrochemicals from Methane (C_1), Ethylene (C_2) and Propylene (C_3)
- Methane
  (a) Manufacture of Chloromethanes (Chlorinated hydrocarbons)
  (b) Manufacture of Synthetic gas
- Ethylene
  (a) Manufacture of ethylene glycol from
    (1) Ethylene chlorohydrins
    (2) Ethylene oxide
  (b) Manufacture of ethyl alcohol by
    (1) Sulphuric acid process and
    (2) Catalytic hydration process
- Propylene
  (a) Manufacture of glycerol

(1) via allyl chloride and
(2) via acrolein

(b) Manufacture of acrylonitrile

List of Reference Books (Industrial Chemistry) :

1. A Text Book of Petrochemicals by Bhaskar Rao
2. Advanced Petrochemicals by Dr. G.N. Sarkar
3. Chemicals from Petrochemicals by A.L. Waddam
4. Reigel's Handbook of Industrial Chemistry by James A. Kent
5. Engineering Chemistry by Jain and Jain
6. Outlines of Chemical Technology by Charles Dryden
7. Industrial Chemistry by B.K. Sharma

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – V
CHEMISTRY [C-502] SYLLABUS
ORGANIC CHEMISTRY & SPECTROSCOPY

Unit-I: Organic Chemistry

[40 Marks]

1. **Name Reactions, Rearrangement and Reagents**: [7 Hours]

   Reactions
   a. Arndt Eistert Reaction
   b. Bischler Napierski Reaction
   c. Leuckart Wallach Reaction

   Rearrangements
   a. Hoffmann Rearrangement
   b. Curtius Rearrangement
   c. Fries Rearrangement

   Reagents
   a. Lithium Aluminium Hydride $LiAlH_4$
   b. Triphenyl phosphine
   c. Sodamide
2. **Alkaloids** [06 hours]

   Introduction, Occurrence, Classification, Isolation, General method of proving structure of Alkaloids, Constitution, Properties and Synthesis of:
   a. Coniine
   b. Nicotine
   c. Papaverine
3. **Carbohydrates** **[**12 hours]

Introduction, Classification and nomenclature, General reactions of Monosaccharides (with reference to Glucose and Fructose)

Inter-conversions:

a. Conversion of Aldose to the corresponding Ketose
b. Conversion of Aldose to the next higher Ketose (Wolform method)
c. Conversion of Aldose to the Ketose having two more carbon atoms (Sowden method)
d. Conversion of Ketose to the corresponding Aldose

Step-up reactions (Ascending in Aldose series)

a. Kiliani Reaction
b. Swoden Nitromethane reaction

Step-down reactions (Descending in Aldose series - Aldohexose to Aldopentose) by Ruff's Method

Configuration of monosaccharides

Ring structure of Aldoses

Determination of ring size of Glucose by

a. Methylation method
b. Periodic oxidation method

Mutarotation of D (+) glucose

4. **Synthetic Drugs, Dyes and Sweetening Agents** **[**7 hours]

Only Synthesis and Uses of

Drugs: Ibuprofen, Atenlol and Adrenaline

Dyes: Orange II, Crysodine G, Auramine O

Sweetening Agents: Saccharin, p-anisylurea and Dulcin

5. Synthesis of Heterocyclic Compounds containing two hetero atoms [7 hours]

Preparation of:

1) Pyrazole
2) Imidazole
3) Isoxazole
4) Thiazole
5) Pyrimidine
6) Pyridazine
7) Oxazine
8) Thiazine
9) Dioxane

Unit-II: Spectroscopy **[35 Marks]**

1. Molecular symmetry [18 Hours]

- Introduction,
- symmetry elements and symmetry operation with illustration
- Definition of Properties of group , subgroup and classes
- Products of symmetry operations
- symmetry point group.C_1, Cs, Ci, Cn, Cnv, Cnh, Dn, Dnh, Dnd, C∞, D∞h, Td, Oh
- Multiplication tables for C_2V, C_3V and C_2h point groups. (Point Group are given in separate page)

2. U.V. spectroscopy [07 Hours]

- Introduction
- Theory of ultra violate spectra
- Instrumentation
- Type of transition in organic molecules ; auxochrome, chromophore ;
- Explanation of bathochromic shift and hypsochromic shift,
- Hyper chromic effects
- Types of bands
- Effect of solvent, franck condon principles
- Application of UV spectra
- Calculation of λ-max (1) Dienes and conjugated dienes (2) enones and dienones ie. unsaturated carbonyl compounds, (3) aromatic carbonyl system

3. Infra red Spectroscopy [10 Hours]

- Introduction
- Range of IR , theory of IR
- Modes of fundamental vibration
- IR active, force constant
- Vibration coupling
- Fermi resonance
- Finger print region
- Instrumentation
- Application of IR
- Structure of organic molecules From IR
- Interpretation of IR for given molecules and problems

Reference Books (Spectroscopy) :

(1) Spectrometric identification of organic compounds
By Silverstrin Bassler (16^{th} Editim)
(2) Elementary organic spectroscopy by Y. R. Sharma.
(3) Spectroscopy of organic compounds by John R. Dyer.
(4) Spectroscopy of organic compounds by P. S. Kalsi
(5) Chemical Application of Group theory by F Albert Cotton
(6) Symmetry in chemistry by H. M. Jahe.
(7) Molecular spectroscopy by B. K. Sharma.
(8) Organic Spectroscopy by B. K. Sharma

SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – V

CHEMISTRY [C-503] SYLLABUS

PHYSICAL CHEMISTRY & ANALYTICAL CHEMISTRY

Unit-I: Physical Chemistry [40 Marks]

1. Second Law of Thermodynamics [12 Hours]

- Limitation of first law of thermodynamics
- Spontaneous process
- Carnot cycle and theorem
- Statements of second law of thermodynamics
- Perpetual motion of second kind (briefly)
- Concept of entropy, Definition of entropy
- ΔS in reversible and irreversible (spontaneous) process
- ΔS in ideal gases
- ΔS of mixture of ideal gas
- ΔS in physical transformations
- Entropy and second law of thermodynamics
- Physical significance of entropy

2. Free Energy and Chemical Equilibrium [10 Hours]

- Work function: its physical significance and variation with V and T
- Free Energy: its significance and variation with P and T
- ΔG for ideal gases, Gibbs Helmholtz equation and its applications

- Criteria for chemical equilibrium
- Vant Hoff reaction isotherm
- Vant Hoff isochore
- Law of active mass
- Clausius Clapeyron equation

3. Crystalline State [10 Hours]

- Difference between crystalline and amorphous solid, Crystal and crystallography
- Three laws of crystallography
- Structure of crystals
- Space lattice and Unit cell, Bravice lattices
- Type of cubic lattice and inter planar spacing
- ***X- rays Diffraction:*** Brags equation, Experimental methods (Rotating crystal and Powder method), Structure of Rock salt (NaCl) and Sylvin (KCl)
- ***Liquid Crystals:*** Introduction, Definition and Classification of liquid crystals (Smectic, Nematic, Cholesteric and Disc shaped)

4. Phase Rule [08 Hours]

- Three component system,
- Method of graphical presentation,
- Types of partially miscible three liquid systems:

(1) One partially miscible pair: Effect of adding third compenent, Nature of tie line, Plait point, Binodle curve, Characteristics of diagram, A is added to binery system, A is constant and B and C varied,

(2) Formation of two pairs of partially miscible liquid,

(3) Formation of three pairs of partially miscible liquid.

- Application of ternary liquid diagram

Reference Books (Physical Chemistry):

(1) Elements of Physical Chemistry, S Glasstone and D Lewis, Macmillon and Co Ltd., New Delhi.

(2) Principles of Physical Chemistry, S H Maron and C F Prutton, Oxford and IBH , New Delhi.

(3) Thermodynamics for Chemists, S Glasstone, Affiliated East West Press Pvt Ltd, New Delhi

(4) Elements of Physical Chemistry, B R Puri, L R Sharma, M S Pathania Vishal publishing Co Jalandhar.
(5) Advanced Physical Chemistry, J. N. Gurtu, Pragati Prakashan, Meerut.
(6) Physical Chemistry, N. Kundu and S. K. Jain, S. Chandand Co. New Delhi
(7) Physical Chemistry, K. L. Kapoor, Macmillan India Ltd. Delhi.
(8) Physical Chemistry, B. K. Sharma Goel Publishing House, Meerut.
(9) Thermodynamics, Dr. Gurdeep Raj, Goel Publishing House Meerut

Unit-II: Analytical Chemistry **[35 Marks]**

1. Errors and statistics [10 Hours]

- Introduction
- Explanation of errors and mistake
- Classification of errors, Determinate and indeterminate errors, Operational and personal error, Instrumental errors and reagent errors, additive and proportional error
- Accuracy and precision, minimization of error
- Calibration of Instruments , blank measurement , independent method parallel method, Standard addition method
- Explanation of Significant figure and its laws with complete interpretation
- Mean and standard deviation , variance and coefficient of variance
- Absolute error and relative error, mean value, deviation and relative mean deviation. Gausian curve and its explanation
- Importance of Q – test and T -test (Student T test)
- Example on errors, significant figures , Q test and T test

[2] Basic Principle of Qualitative analysis only separation [6 Hours]

- Separation of the following in presence of each other (by any method)

(1) Cl^{-}, Br^{-} , I^{-} (2) NO_2^{-}, NO^{-}_3 , Br^{-}
(3) S^{-2} , SO_3^{-2} , SO_4^{-2} (4) PO_4^{-3} , $As\ O_3^{-3}$, AsO_4^{-3}
(5) CO_3^{-2} , SO_3^{-2} , S^{-2} (6) Cu^{+2} , Cd^{+2}

[3] Colourimetry

[07 Hours]

- Introduction

- Growth Drapper law, Lambert's Law, Beayer's Law,Lambert's-Beayer's Law and Derivation, application and deviation of Lambert's Law
- Spectro photometric titration with graph and proper explanation

(1) Deficit of absorbance by product and Titrant
(2) Deficit of absorbance by product and Reagent
(3) Deficit of absorbance by Reagent and Titrant
(4) Deficit of absorbance by product only

[4] Volumetric analysis with example of calculation based on pH, normality, molarity, Ksp etc. [12 Hours]

- Ostwald's law- Regarding indicator – necessary derivation and formula of indicator used in Neutralization, redox, precipitation titration.
- Primary and secondary standard explanation

(1) Explanation of neutralization titration with graph.

(i) Strong acid - Strong base titration
(ii) Weak acid - Strong base titration
(iii) Strong acid – Weak base titration.
(iv) Poly protic acid - Strong base titration

(2) Redox Titration:

- Principle of external and internal indicator in redox titration. e.g. Diphenyl amine , starch & $K_3[Fe(CN)_6]$
- Redox Titration with graph and calculation
- Iodometry and Iodimetry titration
- preparation of standard sodium thiosulphate solution

(3) Precipitation Titration:

- Argentometric Titration (I) Mohar's method (II) Fazan's method (III) olhard's method with use of proper indicator, graph and it's practical application
- Examples of calculation based on pH, Normality, Molarity,Ksp etc

Reference Books (Analytical Chemistry) :

(1) Fundamental of analytical chemistry by skoog & west
(2) Instrumental method of chemical analysis By B. K. Sharma 22 wilhim
(3) Water analysis and nater pollution by V. P. Kudesia
(4) Instrumental method of chemical analysis By Chatwal Amreli
(5) Thin layer chromatography by Egal stall
(6) Book for water analysis: By R.K. Trivali, V. P. Kulesiya.

(7) Analysis cal chemistry by click
(8) Inorganic inflictive analysis by Vogel and Gehani Parekh
(9) Electronic methods of analysis by brewing
(10) Principle of instrumental analysis by S korg.

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – V
LABORATORY COURSE
CHEMISTRY PRACTICALS [C-504] SYLLABUS

[Practical Exam. would be conducted for 1 ½ days for each sem.]

[Total Marks: 105 marks + 45 marks Int.]
[Viva-voce - 10marks Phy.+Org.]

(1) Organic Separation (Mixture of two compounds) [35 marks]

[Minimum 12 mixtures should be done]

Separation & Analysis of an organic mixture containing:

(a) Two solid components using water, $NaHCO_3$, NaOH and HCl for separation

(b) Liquid + liquid component - separation by physical method.

(c) Liquid + solid component - separation by physical method.

(2) Inorganic Volumetric Analysis [30 marks]

[Minimum 8 exercises should be done]

For volumetric exercise all the standard solutions are to be prepared by the students.

(i) Iodometry and Iodimetry

a. Estimation of Cu^{+2} and $CuSO_4.5H_2O$ in the given $CuSO_4.5H_2O$ using 0.05N $Na_2S_2O_3.5H_2O$ solution.
b. Estimation of As^{+3} and As_2O_3 in the given As_2O_3 using 0.05N $Na_2S_2O_3.5H_2O$ solution.

(ii) Complexometric titration:

1. Estimation of the amount of Ni^{+2} in the given $NiSO_4.7H_2O$ solution using 0.02 N EDTA solution.
2. Estimation of the amount of Mg^{+2} and Pb^{+2} in the given solution containing a mixture of Mg^{+2} and Pb^{+2} using 0.02 N EDTA solution
3. Estimation of the amount of Ca^{+2} and Zn^{+2} in the given solution containing a mixture of Ca^{+2} and Zn^{+2} using 0.02 N EDTA solution

4. Estimation of the amount of Fe^{+3} and Cr^{+3} in the given solution containing a mixture of Fe^{+3} and Cr^{+3} using 0.02 N/ 0.01 M $Pb(NO_3)_2$ and 0.02 N/ 0.01 M EDTA solution.

(iii) Redox titration:

Determination of the amount of NO_2^{-1} in the given $NaNO_2$ or KNO_2 solution by reduction method using 0.1 N $KMnO_4$ solution.

(iv) Water Analysis:

To determine the amount of chloride in the given sample of water using 0.02 N $AgNO_3$

(v) To determine the purity of $NaHCO_3$ in the given sample

(3) Physicochemical Exercise [30 marks]

[Minimum 12 exercises should be done]

Conductometry

1. To determine normality and gms/lit of xN HCl and also determine specific conductance by conductometry.
2. To determine normality and gms/lit of the mixture of $HCl+CH_3COOH$ by conductometry.
3. To determine the normality of weak acid by conductometry.
4. To determine the concentration of Ni^{+2} using 0.1M EDTA solution.
5. To determine the normality of $xNAgNO_3$ using 0.5N NaCl by conductometry.

pH metry

1. To determine normality of xN HCl by pH metry.
2. To determine normality and dissociation constant of weak acid (xN CH_3COOH) by pH metry.
3. To determine normality and dissociation constant of dibasic acid (xN oxalic acid/malonic acid/maleic acid) using 0.1N NaOH solution.

Colourimetry

1. Find out the amount of Ni^{+2} in the given solution by colourimetry method.
2. Find out the amount of Fe^{+3} in the given solution by colourimetry method.

Viscosity

1. To determine relative and absolute viscosity of pure liquid A, B, C, D by Ostwald's viscometer.
2. Prepare three different 10%, 5%, 2.5% aqueous solution of Glycerin. Find viscosity of these three solutions as well as unknown concentration solution with the help Ostwald's viscometer.

Refractometer

1. To determine specific refractivity and molecular refractivity of given pure liquid A, B, C, D.
2. To determine specific refractivity and molecular refractivity of glycerin (10%, 5%, 2.5%) and unknown glycerin solution.

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – VI
CHEMISTRY [C-601] SYLLABUS
INORGANIC CHEMISTRY & INDUSTRIAL CHEMISTRY

Unit-I: Inorganic Chemistry [35 Marks]

1. Multi Electron System [12 Hours]

- Concept of spectral terms and term symbols.
- s-s coupling, l-l coupling, l-s coupling, j-j coupling and L-S coupling with vector diagram.
- Derivation of spectral term symbol for P^1, P2, P3, &d^1 to d^9.
- Micro states: definition, calculation and derivation of microstates for p1,p2,d^1&d^2 (pegion hole diagram).
- Hund's rules for the determination of ground state spectral term.

2. Crystal Field Theory - II [12 Hours]

- Jahn-Teller effect: Statement and explanation.
- Tetragonal distortion with example.
- Splitting of d-orbital in square planar complexes with examples.
- Hole formalism.
- Splitting of D and F ground terms (using hole formalism).
- Orgel Diagram of D and F states.
- Selection rules for d-d transition.

- Types of electronic transition in metal complexes.
- Absorption spectrum of Ti^{+3}, Cu^{+2} & Ni^{+2}.

3. Magneto Chemistry [11 Hours]

- Introduction (Magnetic field, Magnetic pole, Intensity of magnetization).
- Magnetic induction.
- Permeability, intensity of magnetism, magnetic susceptibility, molar magnetic susceptibility.
- Magnetic behavior: Diamagnetism, Paramagnetism, Ferro magnetism and Antiferro magnetism.
- Effect of temperature on magnetic behaviour of substances.
- Derivation of equation for total angular magnetic momentum and diamagnetic momentum.
- Determination of magnetic susceptibility by Gouy method.

Reference Books:

(1) Quantum Chemistry– R.K. Prasad, New Age International Publishers
(2) Inorganic Chemistry- James E Huheey (3rd Edition) Harper International SI Edition
(3) Coordination chemistry – Gurdeep Chatwal and MS Yadav, Himalaya publishing House
(4) Principles of Inorganic Chemistry – B.R.Puri, L.R. Sharma & K.C. Kalia; Vallabh Publications, Delhi
(5) Modern aspects of Inorganic Chemitry- H.J. Emeleus and A.G. Sharpe; Routledge & Kegan Paul Ltd., 39 Store street, London WCIE7DD
(6) Advance Inorganic Chemistry (3rd Edition)- F.A. Cotton and G. Wilkinson; Wiley Eastern Pvt. Ltd.

Unit–II : Industrial Chemistry [40 Marks]

1. Glass [10 hours]

- Introduction
- Physical and chemical properties of glass

- Raw materials for manufacture
- Chemical reactions involved
- Method of manufacturing
  - Formation of batch material
  - Melting
  - Shaping
  - Annealing
  - Finishing
- Special types of glasses
- Fused silica glass, High silica glass, optical glass, borosilicate glass, lead glass, coloured glass, opal glass, safety glass, fibre glass, glass wool, pyrex glass, photochromic glass, insulating glass, rare earth glass, vitreosil, photosensitive glass.

2. Oil and Fats [10 hours]

- Introduction
- Distinction between oils and fats
- Properties of fats and oils
- Classification of fats and oils
- Manufacturing of cotton seed oil
- Expression method
- Solvent extraction method
- Refining of crude vegetable oil
- Hydrogenation of oils
- Optimum conditions for the process
- Dry process
- Wet process
- Analysis of oils and fats
- Saponification value
- Acid value
- Iodine value
- Reichert – Meissl (RM) value

3. Soaps and Detergents [10 hours]

- Introduction to soap
- Raw materials for manufacture
- Methods for manufacture of soap
  (a) Batch process
  (b) Continuous process
- Types of soap
- Toilet soap, transparent soap, shaving soap, Neem soap, Liquid soap

- Recovery of glycerin from spent lye.
- Introduction to detergents
- Principal group of synthetic detergents
- Bio degradability of surfactants
- Classification of surface active agents
- Anionic detergents
- Manufacture of anionic detergents
  (a) Oxo Process
  (b) Alfol Process
  (c) Welsh Process
- Cationic detergents
- Manufacture
- Non – Ionic detergents
- Manufacture by batch process
- Amphoteric detergents
- Manufacture of shampoo

4. Environmental Chemistry [10 hour]

- Environment – definition and introduction
- Segments of environment
  (a) atmosphere
  (b) Hydrosphere
  (c) Lithosphere
  (d) Biosphere
- Air Pollution
- Introduction
- Green house effect
- Major sources of air pollution
- Photochemical smog and acid rain
- CFC and ozone depletion
- Sources and effects of NO_X and SO_X
- Control of Air pollution
- Water pollution
- Introduction
- Classification of water pollution
  (a) Physical pollution
  (b) Chemical pollution
  (c) Biological pollution
  (d) Physiological pollution
- Sources of water pollution
  (a) Sewage and domestic waste
  (b) Industrial effluents

(c) Agricultural discharges
(d) Fertilizers
(e) Toxic metals
(f) Siltation
(g) Thermal pollutions
(h) Radioactive materials

- Water Pollution Control
- Dissolved Oxygen (D.O.) determination
- Chemical Oxygen Demand (C.O.D.) determination
- Biological Oxygen Demand (B.O.D.) determination

Reference Books (Industrial Chemistry):

(1) Environment Pollution Control Engineering by Rao C.S.

(2) Industrial Chemistry by B.K. Sharma

(3) Environmental Chemistry by A.K. De

(4) Environmental Solution of Analysis by S.M. Khopkar

(5) Engineering Chemistry by Jain & Jain

(6) Regiel's Handbook of Industrial Chemistry by Jomes A. Kent

(7) Environmental Chemistry by Sharma & Kaur

(8) Outlines of Chemical Technology by Charles Dryden

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – VI
CHEMISTRY [C-602] SYLLABUS
ORGANIC CHEMISTRY & SPECTROSCOPY

Unit-I: Organic Chemistry [35 Marks]

1. Terpenoids [7 hours]

- Introduction
- Occurrence, Isolation, General characteristics of Terpenoids, Isoprene Rule
- Constitution and Synthesis of :

a. Citral
b. α-Terpineol

2. Amino acids, Peptides and Proteins [8 hours]

- Introduction
- Classification of amino acids name and formula
- Synthesis of amino acids by:
  a. Amination of α-halogen acids
  b. Gabriel pthalimide synthesis
  c. Hofmann Degradation
  d. Erlen-meyer azlactone synthesis
  e. Hydantoin method
- Physical properties of amino acids, Chemical properties of amino acids, Isoelectric point
- Introduction to Polypeptides
- Synthesis of Polypeptides by:
  a. Bergmann Method
  b. Sneehan's Method (use of Phthaloyl group)
  c. Fischer's Method (use of p-toluenesulphonylchloride)
- Introduction and classification of proteins
- Constitution of Thyroxine, Synthesis of Thyroxine

3 **Synthetic Explosive, Perfumes and Insecticides** [06 hours]

- Synthesis and uses of :

Explosives:

a. RDX (Research Development Explosive)
b. TNT (Trinitrotoluene)
c. PETN (Pentaerythritol tetranitrate)

Perfumes:

a. Musk Xylene

b. Musk Ketone
c. Musk Ambrette

Insecticides:

a. Baygon
b. Carbendazin
c. Parathion

4. **Polynuclear Aromatic Hydrocarbons [7 Hours]**

Introduction, Synthesis and chemical properties:

a. Biphenyl
b. Diphenyl methane
c. Naphthalene
d. Anthracene

5. **Conformational Isomerism [7 Hours]**

- Conformation of acyclic system
- Conformational analysis of ethane
- Conformational analysis of n – butane
- Conformation of cyclic system: Cyclohexane and cyclopentane
- Conformational analysis of cyclohexane: Boat form and Chair form
- Conformation of monosubstituted cyclohexane

Reference Books (Organic Chemistry):

(1) Synthetic Organic Natural Products (Vol. I&II) by O.P Agrawal.
(2) A Text Book of Organic Chemistry (II Edition) by Raj K. Bansal
(3) Medicinal Chemistry by Ashutoshkar
(4) Pharmaceutical Chemistry by Axel Kleemann & Jugen Engel (IV Edition – Thieme Stuttgart New York)
(5) Organic Name reactions by Gautam Brahmachari
(6) Chemistry of Alkaloids -University Granth Nirman Board Ahmedabad

(7) Reactions and Rearrangements by Gurdeep Chatwal

(8) Name Reactions in Organic Synthesis by Dr. A.R.Parikh et. al

(9) Organic Chemistry of Natural Products by Gurudeep Chatwal Vol L

Unit-II: Spectroscopy [40 Marks]

1. NMR Spectroscopy [20 Hours]

- Introduction, principle
- Nuclear quantum number
- equivalent and nonequivalent protons with illustrations ; enantiomeric and diasteriomeric protons, shielding and de shielding of protons;
- Chemical shift
- Paramagnetic anisotropic effect
- Relative intensity of signals
- Spin- spin coupling and coupling constant
- Deuterium labeling
- Application of NMR
- Problems for determination of structure of organic molecules

2. Mass Spectroscopy [05 Hours]

- Introduction
- Classification of spectroscopy origin and basic principles
- Instrumentation
- General fragmentation modes
- Important future for the mass spectra of alkanes

3. Problems based on application of U.V. IR, NMR spectroscopy with empirical and molecular formula [15 Hours]

Reference Books (Spectroscopy) :

(1) Spectrometric identification of organic compounds

By Silverstrin Bassler (16th Edition)
(2) Elementary organic spectroscopy by Y. R. Sharma.
(3) Spectroscopy of organic compounds by John R. Dyer.
(4) Spectroscopy of organic compounds by P. S. Kalsi
(5) Chemical Application of Group theory by F Albert Cotton
(6) Symmetry in chemistry by H. M. Jahe.
(7) Molecular spectroscopy by B. K. Sharma.
(8) Organic Spectroscopy by B. K. Sharma

SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – VI

CHEMISTRY [C-603] SYLLABUS

PHYSICAL CHEMISTRY & ANALYTICAL CHEMISTRY

Unit-I: Physical Chemistry [35 Marks]

1. Third Law of Thermodynamics [06 Hours]

- Nernst heat theorem
- Third law of thermodynamics
- Determination of absolute entropies of solids, liquids and gases
- Applications of third law of thermodynamics (ΔS^0, ΔG^0 and equilibrium constant of chemical reaction)
- Tests of third law of thermodynamics, Residual entropy

2. Partial Molar Properties [07 Hours]

- Definition
- Concept of chemical potential, Gibbs-Duhem equation
- Variation of chemical potential with temperature and pressure
- Determination of partial molar properties by method of intercept
- Applications of chemical potential (Henry's law, Rault's law and Nernst's distribution law)

3. Activity of Electrolytes [10 Hours]

Ionic Activity:

- Introduction
- Derivation of $a_2 = a_+^{\nu+} a_-^{\nu-}$ and $a_2 = a_+ a_-$ for 1-1 electrolyte
- Mean Activity $a_\pm$, its relation with a_+ and a_-

- Relationship between a_2 and $a_\pm$ i.e. $a_2 = a_\pm^{\nu}$
- Mean ionic activity coefficient $f_\pm$ and f_+, f_-

Ionic Strength: Definition, Explanation and Equation
Debye Huckel Limiting Law (Without derivation):

Derivation of $-\log f_\pm = Az_+z_- \mu^{1/2}$

- Interpretation of Equation
- Graph of $-\log f_\pm \rightarrow \mu^{1/2}$ and its explanation / discussion
- Empirical correction of Debye Huckel Limiting Law for
  (1) Size of ion and
  (2) Orientation of solvent molecules

Methods to Determine Activity Coefficient:

- Solubility method
- emf methods: (1) Chemical cell with transference
  (2) Concentration cell without transference

Examples based on theory.

4. Electrochemistry [12 Hours]

- Concentration cells: Definition, **(1)** Electrode concentration cells **(2)** Electrolyte concentration cells,
- Concentration cells without transference,
- Concentration cells with transference,
- Liquid junction potential, Elimination of liquid junction potential.
- Applications of emf measurements: Determination of
  (1) Solubility of sparingly soluble salts,
  (2) Valency of metal ion,
  (3) Dissociation constant of weak acid,
  (4) Transport number of ion**,**
  (5) Ionic product of water,
  (6) Degree of hydrolysis
  (7) pH by different electrodes
- Example

Reference Books (Physical Chemistry):

(1) Elements of Physical Chemistry, S Glasstone and D Lewis, Macmillon and Co Ltd., New Delhi
(2) Principles of Physical Chemistry, S H Maron and C F Prutton, Oxford and IBH, New Delhi
(3) Thermodynamics for Chemists, S Glasstone, Affiliated East West Press Pvt Ltd, New Delhi
(4) Elements of Physical Chemistry, B R Puri, L R Sharma, M S Pathania Vishal publishing Co Jalandhar.
(5) Advanced Physical Chemistry, J. N. Gurtu, Pragati Prakashan, Meerut.
(6) Physical Chemistry, N. Kundu and S. K. Jain, S.Chandand Co. NewDelhi
(7) Physical Chemistry, K. L. Kapoor, Macmillan India Ltd. Delhi
(8) Physical Chemistry, B. K. Sharma Goel Publishing House, Meerut.
(9) Thermodynamics, Dr. Gurdeep Raj, Goel Publishing House Meerut
(10) Introduction to Electrochemistry, S. Glasstone , Affiliated East West Press Pvt Ltd, New Delhi

Unit-II: Analytical Chemistry [40 Marks]

1. Electrochemistry (conductometry) [10 Hours]

- Electric transport , conductance in metals and in electrolyte solution
- Specific conductance, equivalent conductance
- Importance of conductivity electrodes. and platinization of electrodes
- Variation of specific conductance with dilution as well as area of cross section of dip type electrode and distance between two plates of electrodes etc.
- Kohl raurch law and its importance, cell constant and it's importance.

- **Conductometric Titration :**
  (1) Strong acid - strong base
  (2) Strong acid - Weak base
  (3) Weak acid – Strong base
  (4) Weak acid – Weak base
  (5) Mixture of strong acid + Weak acid - strong base

- **Precipitation Titration :**
  (1) $AgNO_3$ – NaCl
  (2) $BaCl_2$ – K_2SO_4
  (3) $Ba(OH)_2$ – $MgSO_4$

- **Replacement Titration :**

(1) Salt of weak acid – strong acid
(2) Salt of weak base – strong base

- Degree or hydrolysis and Hydrolysis constant
- Determination of solubility and solubility product of sparingly soluble salt, for the measurement of conductivity
- Importance of conductivity water and temperature for the measurement of conductivity

2. Chromatography [12 Hours]

- Introduction,
- Classification of chromatography - types of chromatography
- Detail study of
  (1) Adsorption (Column) chromatography
  (2) Partition chromatography – paper and TLC.
  (3) Gas chromatography- GLC & GSC
  (4) Ion exchange chromatography.
  - Application such as main physical characteristic of chromatography: Solubility, adsorption value, volatility , Rf value , Rt & Rx value , nature of adsorption etc.

(I) Column chromatography:

- Principles,
- Method of separation of green leat pigment , mixture of inorganic ,vitamins ,colors of flowers etc. separation of α, β, γ carotene from carrot.

(II) Partition chromatography:

(1) Paper chromatography
(2) TLC

(1) Paper chromatography:

- Principle of paper chromatography
- Experimental methods like :

Ascending and Descending method containing one dimensional and two dimensional method; circular method and it's Rf value , Rx value ;circulation method, separation of amino acid, sugar, phenyl amine glycine and Fe^{+2} , Co^{+2} , Ni^{+2} mixture using spray reagent ninhydrine and aniline phthalate

(b) TLC:

- Introduction of principles ;
- Method of preparation of chromatoplate, Experimental techniques, superiority of TCL over other chromatographic Techniques, Application of TLC.

(III) Gas chromatography

- Introduction,
- principle of GLC and GSC

(1) GLC :

Instrumentation, Evaluation selection and characteristic of carrier gas, Effect of temperature & pressure of gas, application.

(2) GSC :

Methods and its application.

(IV) Ion Exchange chromatography:

- Introduction
- Principle
- Type of resins
- Properties of ion exchange resins
- Basic requirement of useful resins
- Method of separation with illustration curve
- Application of ion exchange resins

3. Introduction of Complexometry Titration [10 Hours]

- Method of preparation of standard E.D.T.A. Solution,
- velcher's law explanation of pm → EDTA vol.,Graph with stability constant value.
- Types of EDTA Titration (I) Direct Titration (II) Back Titration (III) Substitution Titration (IV) Alkalimetry titration mixture with the help of masking and demasking agent ;
- Principle of metal ion indicator,Use of EBT, calcon , muroxide with structure and characteristic.

4. Potentiometric and pH metry: [08 Hours]

- Introduction and interpretation of pH metry and potantiomtry.
- Importance of indicator and reference electrode in the measurement of EMF and pH

E.M.F. method:

(I) Study of acid – base Titration

(II) Redox Titration

(III) Argentometric Titration include mixture of Cl^-, Br^-, I^- with graph and proper explanation.

pH metry :

- Definition,
- Interpretation of various methods of determining pH value like pH paper method (Demonstration only), potentiometric method using only hydrogen electrode as indicator electrode and calomel electrode as reference electrode to determine pH value.
- Weak acid strong base Titration with curve and determination of dissociation constant (Ka) of weak acid.

Reference Books (Analytical Chemistry):

(1) Fundamental of analytical chemistry by skoog & west
(2) Instrumental method of chemical analysis By B. K. Sharma 22 wilhim
(3) Water analysis and water pollution by V. P. Kudesia
(4) Instrumental method of chemical analysis By Chatwal Amreli
(5) Thin layer chematography by Egal stall
(6) Book for water analysis: By R.K. Trivali, V. P. Kulesiya.
(7) Analytical Chemistry by click
(8) Inorganic inflictive analysis by Vogel and Gehani Parekh
(9) Electronic methods of analysis by brewing
(10) Principle of instrumental analysis by S korg.

SAURASHTRA UNIVERSITY
B.Sc. SEMESTER – VI
LABORATORY COURSE
CHEMISTRY PRACTICALS [C-604] SYLLABUS

[Practical Examination would be conducted for 1 ½ days for each semester]

[Total Marks: 75 marks]

(1) Inorganic Qualitative Analysis (six radicals) [30 marks]

[Minimum 12 inorganic mixtures should be analyzed]

To analyze the given inorganic mixture containing six radicals

(2) Organic Synthesis (% age of yield, crystallization, melting point)

[Minimum 8 syntheses should be done] **[20 marks]**

I. Acetylation / Benzoylation:

1. Acetylation of salicylic acid
2. Acelytation of aniline
3. Acelytation of phenol
4. Benzoylation of aniline
5. Benzoylation of phenol

II. Aliphatic Electrophilic substitution:

1. Preparation of iodoform from ethanol
2. Preparation of iodoform from acetone

III. Aromatic Electrophilic Substitution:

Nitration:

1. Preparation of m-dinitrobenzene,
2. Preparation of nitro acetanilide.

Halogenation:

1. Preparation of p-bromo acetanilide,
2. Preparation 2:4:6 -tribromo phenol

IV. Diazotization / Coupling:

1. Preparation of methyl orange
2. Preparation of methyl red

V. Oxidation: Preparation of benzoic acid from benzaldehyde

(3) Physicochemical Exercise **[25 marks]**

[Minimum 12 exercises should be done]

Potentiometry

1. To determine normality and dissociation constant of benzoic acid using 0.1N NaOH.
2. To determine normality of given acid xN HCl using NaOH solution.
3. To determine concentration of xN FAS using $K_2Cr_2O_7$.
4. To determine normality of each halide in the mixture using 0.1N $AgNO_3$ solution.
5. To determine normality and dissociation constant of benzoic acid using 0.1N NaOH.

Polarimeter

1. To determine specific rotation of three different concentration (10%, 5%, 2.5%) of dextrose solution. From graph find out the unknown concentration by plotting concentration v/s rotation angle.

2. Study the inversion rate of sugar in presence of 1N HCl and determine the rate of reaction.

Surface tension:

1. Find the surface tension of the liquids A, B, and C by using Drop-weight method. Find the value of Parachor of liquids and CH_2 group.

Thermodynamics:

1. Calculate entropy of vaporization (ΔSv) of a given liquid by plotting a graph of log (1/time) vs. (1/temperature).

Chromatography:

2. To determine Rf value of individual and mixture of amino acid by ascending paper chromatography.
3. To determine Rf value of individual and mixture of amino acid by circular paper chromatography.
4. To determine Rf value of individual and mixture of amino acid by thin layer chromatography (TLC).
5. To determine Rf value of individual and mixture of metal ions by ascending paper chromatography.
6. To determine Rf value of individual and mixture of metal ions by circular paper chromatography.

SAURASHTRA UNIVERSITY

B.Sc. SEMESTER – VI

CHEMISTRY PRACTICALS [C-604] SYLLABUS

Project Report

[Total Marks: 100 marks {60 Project Report + 40 Presentation}]

Project Report must be submitted in 35 to 50 pages

Presentation using OHP or PowerPoint for 5 minutes