

THIRUVALLUVAR UNIVERSITY
BACHELOR OF SCIENCE
B.Sc. INDUSTRIAL CHEMISTRY DEGREE COURSE
(With effect from 2020 - 2021)

The Course of Study and the Scheme of Examinations

S. No.	Part	Study Components		Ins. Hrs / week	Credit	Title of the Paper	Maximum Marks		
		Course Title					CIA	Uni. Exam	Total
SEMESTER I									
1	I	Language	Paper-1	6	4	Tamil/Other Languages	25	75	100
2	II	English (CE)	Paper-1	6	4	Communicative English I	25	75	100
3	III	Core Theory	Paper-1	6	4	General Chemistry - I	25	75	100
4	III	Core Practical	Practical-1	3	0	Volumetric Analysis	0	0	0
5	III	Allied -1	Paper-1	4	3	Industrial Chemistry I	25	75	100
6	III	Allied- 1	Practical-1	3	0	Industrial Chemistry Practical	0	0	0
7	III	PE	Paper 1	6	3	Professional English I	25	75	100
8	IV	Environmental Studies		2	2	Environmental studies	25	75	100
		Sem. Total		36	20		150	450	600
SEMESTER II									
8	I	Language	Paper-2	6	4	Tamil/Other Languages	25	75	100
9	II	English (CE)	Paper-2	6	4	Communicative English II	25	75	100
10	III	Core Theory	Paper-2	5	4	General Chemistry - II	25	75	100
11	III	Core Practical	Practical-1	3	2	Volumetric Analysis	25	75	100
12	III	Allied-1	Paper-2	4	3	Industrial Chemistry II	25	75	100
13	III	Allied Practical - 1	Practical-1	2	2		25	75	100
14	III	PE	Paper 1	6	3	Professional English II	25	75	100
15	IV	Value Education		2	2		25	75	100
16	IV	Soft Skill		2	1		25	75	100
		Sem. Total		36	25		225	675	900

THIRUVALLUVAR UNIVERSITY
B.Sc., INDUSTRIAL CHEMISTRY SYLLABUS UNDER CBCS
(With effect from 2020 - 2021)

SEMESTER I
PAPER – 1 GENERAL CHEMISTRY – I

Objective:

Basic concepts regarding Atomic Structure, Periodic Properties, Bonding Concepts, Ionic Bond, VSEPR and MO Theories, Nomenclature of Organic Compounds, Hybridisation, Reaction Intermediates, States of Matter, Principle of Volumetric Analysis, Related Problems and Applications wherever necessary are to be taught for I- Semester.

Course Outcomes:

Upon completion of this course, the students will be able to

- 1) Recollect the Chemistry of Quantum Numbers.
- 2) Review and apply periodicity of properties.
- 3) Discuss various types of bonding through VB & MO theories.
- 4) Name simple Aliphatic and Aromatic Compounds.
- 5) Illustrate and apply electron displacement effects and reaction mechanisms.
- 6) Elaborate the basic concepts of solid, liquid and gaseous states.
- 7) Apply the principles of Volumetric Analysis.

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UNIT-I ATOMIC STRUCTURE

1.1 Quantum numbers n , l , m and s – Pauli's exclusion principle – Energy distribution and orbitals - Hund's rule of maximum multiplicity - Aufbau's principle – Electronic Configuration of elements - Stability of Half-filled and completely filled orbitals. Shapes of s , p , d and f orbitals.

1.2 Classification of elements – General characteristics of s , p , d and f - Block elements – Periodicity of properties- Definition and Periodicity of the following properties – Atomic radii and Ionic radii - Factors affecting the Atomic radii and Ionic radii.

1.3 Ionisation potential, Electron affinity and Electronegativity - Factors affecting the Ionisation potential, Electron affinity and Electronegativity – Pauling scale – Mulliken electronegativity scale – Applications of Electronegativity regarding the Bonding nature. Trends in periodic table and applications in predicting and explaining the chemical behavior.

UNIT- II CHEMICAL BONDING

2.1 Ionic bond - Conditions for the formation of ionic bond - General properties – Energetics of formation of NaCl from Na^+ and Cl^- - Hydration energy, Lattice energy and their applications – Born-Haber cycle - Polarisation of ions- Fajan's rule - Transition from ionic to covalent character.

2.2 Covalent bond - Conditions for the formation of covalent bond - General properties - Polarity of bonds - Orbital overlap - Bond lengths and Bond energies - Hybridisation - Sigma and Pi bonds - VSEPR theory - Geometries of BeCl_2 , BF_3 , NH_3 , CH_4 , SF_4 , ICl_2^- , H_2O , PCl_5 , ClF_3 , XeF_6 , SF_6 and IF_7 molecules - Partial ionic character of covalent bond - Percentage of ionic character from dipole moment and electronegativity difference.

2.3 Molecular Orbital theory – Bonding and Anti-bonding orbitals - Relative order of

Energies of molecular orbitals - MO diagram of H_2 , He_2 , O_2 , O_2^+ , O_2^- , N_2 , F_2 , HF and CO - Bond Order - Stability and Magnetic properties of the molecules - Comparison of VB and MO theories. Hydrogen bonding-types, examples and effect on properties.

UNIT- III BASIC CONCEPTS OF ORGANIC CHEMISTRY

3.1 Classification of Organic Compounds – Nomenclature of Organic Compounds –

Functional Groups - Homologous Series - IUPAC Recommendations for Naming Simple Aliphatic and Alicyclic Compounds.

3.2 Basic concepts of bonding in organic chemistry - Hybridisation – Definition – Geometry of Molecules - Methane, Ethane, Ethylene, Acetylene and Benzene - Electron displacement effects - Inductive - Inductomeric - Electromeric – Mesomeric Effect - Resonance - Hyperconjugation and Steric Effects.

3.3 Cleavage of bonds - Homolytic and Heterolytic fission of carbon-carbon bond – Methods to determine the Reaction Mechanism - Reaction intermediates - Structure and Stability of Carbocations, Carbanions and Free radicals.

UNIT-IV STATES OF MATTER

4.1 Gaseous state - Kinetic gas equation - Postulates and Derivation - Gas laws from the kinetic gas equation - Kinds of velocities - Mean, RMS, Most Probable Velocities - Calculation of molecular velocities - Maxwell's distribution of Molecular Velocities (No derivation) - Effect of Temperature on velocity distribution - Equipartition of energy - Heat capacity on molecular basis - Virial equation of state - Boyle temperature - Coefficient of Compressibility and Thermal expansion.

4.2 Liquid state - Density – Diffusion - Viscosity – Evaporation - Surface tension Determination using Stalagmometer - Effect of temperature on surface tension - Parachor - Definition and Applications only - Coefficient of Viscosity- determination using Oswald's Viscometer- Effect of Temperature and Pressure - Liquid crystals - Classification and Applications.

4.3 Solid State - Crystal lattices - Symmetry elements in crystals - Unit cell- Seven crystal systems - Space lattice - Bravais lattices - Laws of Crystallography-law of constancy of inter facial angles and Rational Indices- Miller indices, X-ray diffraction by crystals.

UNIT-V PRINCIPLES OF VOLUMETRIC ANALYSIS

5.1 Definitions of Molarity, Molality, Normality and Mole Fraction – Their Calculations - Definition and Examples for Primary and Secondary standards - Calculation of Equivalent Weight of Acid, Base, Oxidising Agent, Reducing Agent and Salts.

5.2 Principles of Volumetric Analysis - Theories of Acid- Base, Redox, precipitation titrations, Complexometric Iodometric and Iodimetric titrations.

5.3 Theories of indicators- Choice of indicators - Acid-base indicators - Redox, Metal ion and Adsorption indicators.

ALLIED – 1

PAPER – 1

INDUSTRIAL CHEMISTRY – I

Objectives:

Cements, Ceramics, Refractories, Adhesives, abrasives, Pulp and Paper - Introduction - classification - preparation - Manufacture - properties - Requirements - Composition - Mechanism - applications.

UNIT-I

1.1 INORGANIC CEMENTING MATERIALS - Introduction - Lime and its manufacture - Gypsum Plaster - Cement - Types of cement. - Chemical Composition

1.2 Manufacture of Portland cement - Chemical Composition of Portland Cement - Setting and Hardening of Portland Cement. Heat of Hydration of Cement - Special Cement – Concrete and RCC - Decay of Concrete.

UNIT-II

2.1 GLASS AND CERAMICS - Introduction - Manufacture of Glass - Varieties of Glasses.

2.2 Plasticity of Clay - White wares - Glazing - applications - Earthenware's and stoneware's – Optical Fibers.

UNIT-III

3.1 REFRACTORIES - Introduction - Classification - Manufacture of Refractories - Cermets - Insulating refractories - Requirements of a refractory.

3.2 Non-petroleum Fuels - Combustion - Mass analysis from volume analysis and vice-versa Flue gas-analysis - Efficiency of combustion.

UNIT-IV

4.1 ADHESIVES - Introduction - Classification of adhesives - Adhesive Action - Development of Adhesive Strength. Solvent Responsive Adhesives - Uses of Solvent Responsive Adhesives. Chemically reactive adhesives.

4.2 Preparation of adhesives - Synthetic resin adhesives – Rubber based adhesives - Cellulose and silicate adhesives - Uses of adhesives.

UNIT-V

5.1 Abrasives - introduction - Natural Abrasives - Artificial Abrasives – Grinding Wheels.

5.2 Pulp and paper - Introduction - Manufacture of pulp - Sulphate pulp - Soda pulp - Rag pulp - Beating, refining, filling, sizing and coloring - manufacture of paper.

SEMESTER II
PAPER – 2
GENERAL CHEMISTRY - II

OBJECTIVES:

- Basic knowledge on s- and p- Block Elements, Group Study, Hydrocarbons, Cycloalkanes, Dienes, Quantum Chemistry, Thermochemistry, First Law of Thermodynamics, Derivation of Equations, Related Problems, Reaction Mechanism and Applications wherever necessary are to be taught for II- Semester.

Course Outcomes:

Upon completion of this course, the students will be able to

- 1) Compare the basic properties of elements and their Compounds of s & p – block elements.
- 2) Explain the reaction mechanisms of alkanes, alkenes and alkynes and predict the products.
- 3) Classify dienes and analyze the stability of alkanes, alkenes and cycloalkanes.
- 4) Recollect the basic concepts of Quantum Theory and Thermodynamics.
- 5) Calculate the thermodynamic parameters using thermo chemical equations and data.

UNIT-I s- and p- Block Elements

1.1 Alkali metals - Li, Na, K, Rb and Cs - Occurrence - Comparative study of Elements with respect to Oxides, Halides, Hydroxides and Carbonates - Exceptional property of Lithium - Diagonal Relationship of Li with Mg.

1.2 Alkaline earth metals - Be, Mg, Ca, Sr and Ba - Occurrence - Comparative study of the elements with respect to Oxides, Hydroxides, Halides, Sulphates and Carbonates - Exceptional property of Beryllium - Diagonal relationship of Be with Al - Comparison of Alkaline Earth Metals with Alkali Metals - Magnesium acting as bridge element between II A and II B groups - Magnesium resembles Zinc.

1.3 p- Block elements - Boron family - Group discussion - Anomalous behaviour of Boron - Diagonal Relationship between Boron and Silicon - Electron deficiency and Electron acceptor behaviour of Boron trihalides - Bonding in Diborane (Hydrogen-bridge structure) - Preparation, Properties, structure and Uses of Borazine, NaBH_4 , LiAlH_4 and boron nitride.

UNIT-II HYDROCARBONS

2.1 Alkanes - Methods of preparation of alkanes - Wurtz method, Kolbe's method and Reduction of alkyl halides - Physical and Chemical Properties of alkanes - Mechanism of Free Radical Substitution in alkanes – Halogenation and Reactivity.

2.2 Alkenes - Properties of alkenes – Electrophilic and Free radical addition - Addition reactions of Alkenes with mechanism - Addition of Hydrogen, Halogens, Hydrogen Halide (Markownikoff's rule) - Hydrogen bromide (Peroxide effect) - Sulphuric Acid, Water, BH_3 , Ozonolysis, Hydroxylation with KMnO_4 - Allylic substitution by NBS.

2.3 Alkynes - Acidity of alkynes - Addition of hydrogen - Hydroboration - Hydrohalogenation - Addition of hypohalous acid, Hydration - Addition of water with HgSO_4 catalyst - Oxidation with KMnO_4 – Ozonolysis - Formation of Acetylides.

UNIT-III DIENES AND CYCLOALKANES

3.1 Dienes – Classification - Conjugated, Isolated and Cumulative Dienes - Stability of

Dienes - 1, 2- and 1, 4- Addition reactions of H_2 and HX with mechanisms – Synthesis of dienes – 1, 3 - Butadiene, Isoprene and Chloroprene - Diels-Alder reaction.

3.2 Cycloalkanes - Preparation using Wurtz's reaction, Dieckmann's ring closure and Reduction of aromatic hydrocarbons - Substitution and Ring opening reactions.

3.3 Stability of Alkanes, Alkenes and Cycloalkanes - Bayer's strain theory - Theory of Strainless rings.

UNIT-IV QUANTUM CHEMISTRY AND THERMOCHEMISTRY

4.1 Planck's Quantum theory of radiation - Photoelectric Effect - Compton Effect - Wave mechanical concept of the atom - de Broglie's relationship – Davisson and Germer experiment - Wave nature of electron - Heisenberg's Uncertainty Principle.

4.2 Schrodinger wave equation (Without derivation) - Significance of wave functions ψ and ψ^2 - Shapes of s, p and d- orbitals.

4.3 Thermodynamics - Definition and Explanation of terms - System, Boundary, Surroundings - Homogeneous and Heterogeneous systems – Open, Closed and Isolated systems -Intensive and Extensive properties - State of a system - Independent state variables - Dependent state variables - Thermodynamic functions - State and Path functions.

UNIT-V THERMODYNAMICS

5.1 Thermodynamic processes - Types of processes - Cyclic - Reversible – Irreversible - Isothermal –

Adiabatic Process - Exact and Inexact Differentials - Concept of Heat and Work - Zeroth Law of Thermodynamics.

5.2 First law of Thermodynamics - Statement and Equation – C_p and C_v Relationship - Calculation of w , q , ΔE and ΔH for the Expansion of Ideal Gases under Reversible, Isothermal and Adiabatic Conditions.

1.3 Thermochemistry - Heat of a reaction - Exothermic and Endothermic reactions - Calculation of ΔH from ΔE and vice versa - Thermochemical equations - Bond dissociation energy - Calculation from thermochemical data - Variation of Heat of a reaction with temperature - Kirchoff's Equation and Its significance.

CORE PRACTICAL
Paper – 1
VOLUMETRIC ANALYSIS

Acidimetry

1. Estimation of Borax - Standard Sodium Carbonate
2. Estimation of Sodium Hydroxide - Standard Sodium Carbonate
3. Estimation of HCl – Standard Oxalic Acid.

Iodometry

4. Estimation of Copper - Standard Copper Sulphate
5. Estimation of Potassium Dichromate - Standard Potassium Dichromate

Complexometry

6. Estimation of Magnesium using EDTA.
7. Estimation of Zinc using EDTA

Dichrometry

8. Estimation of Ferrous Iron using Diphenyl amine / N- pPhenylanthranillic acid as indicator.

Precipitation titration

9. Estimation of Chloride in neutral medium (Demonstration experiment).

Permanganometry

10. Estimation of Ferrous Sulphate – Standard FAS.
11. Estimation of Oxalic Acid – Standard Oxalic Acid.

- Students must write Short Procedure for the given estimation in Ten Minutes during the examination and submit the Paper for Evaluation.

ALLIED – 1
PAPER – 2
INDUSTRIAL CHEMISTRY – II

Objectives:

Elaborate study of Fuels Introduction - classification - preparation - properties - their sources of energy - storage - alternate fuels - applications

UNIT-I

1.1 FUELS AND COMBUSTION - Introduction - Classification of Fuels - Calorific Value – Theoretical Calculation of Calorific Value of a Fuel Gross calorific value and net calorific value – Characteristics of a Good Fuel - Solid fuels - Wood.

1.2 Coal - Classification of Coal by Rank - Selection of Coal - Analysis of Coal and its significance

UNIT-II

2.1 Types of coking - Types of Carbonization of Coal - Role of Sulphur in Coal - Role of Ash in Coal

2.2 Gaseous fuels - Producer Gas - Water Gas - Natural Gas – Oil Gas - Biogas - Components - composition - preparation – advantages - disadvantages and applications of Coal gas - Gobar gas - LPG

UNIT-III

3.1 Liquid fuels - Petroleum - Cracking - Advantages of catalytic cracking over thermal cracking - Synthetic Petrol.

3.2 Refining of Gasoline – Reforming - Knocking - Octane number of Gasoline - Diesel Engine Fuels - Diesel - Octane number of Diesel Oil - Diesel index.

UNIT-IV

4.1 Residual fuel oils - Asphalt - Aviation fuel - advantages - Kerosene as a fuel.

4.2 Analysis and testing of liquid and gaseous fuels - Utilization of fuels - Solar power.

UNIT-V

5.1 Other sources of energy – Electricity Power - Modern Concept of Fuel - Fuels for Metallurgy.

5.2 Power Alcohol - Recent Advances In Fuel Technology. Alternative Fuels – Alcohols – Promising Biofuel : An Alternative Source to Diesel and Gasoline - Control of Pollution in Refineries.

**ALLIED PRACTICAL
PAPER 1 & 2
INDUSTRIAL
CHEMISTRY**

WATER TESTING

- 1 Estimation of total dissolved solids in the given water sample (TDS) (Only for demonstration)
- 2 Estimation of total suspended solids in the given water sample (TSS) (Only for demonstration)
- 3 Determination of total permanent and temporary hardness of water using EDTA.
- 4 Determination of acetic acid in commercial vinegar using NaOH.
- 5 Determination of alkali content in antacid tablet using HCl.
- 6 Estimation of calcium in chalk - Permanganometry.
- 7 Limit test for Sulphate
- 8 Limit test for Chloride
- 9 Limit test for Iron
- 10 Limit test for Lead