Vivekanand Education Society's
College of Arts, Science and Commerce
(Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Accredited by NAAC "A Grade" in 3rd Cycle - 2017
Best College Award – Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) and STAR College Grant (DBT)

Affiliated to the

University of Mumbai

Syllabus for

Program: B.Sc. (Chemistry)

(Program code: VESUSCH)

As per Choice Based Semester and Grading System (CBSGS)
with effect from Academic Year 2022 - 2023

Program Outcomes (PO):

A leaner will be able to:

PO1 Demonstrate analytical skills in applying appropriate science principles and methodologies to solve a wide range of problems.

PO2 Design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.

PO3 Demonstrate professional behavior of being unbiased, and truthful in all aspects of work as an individual as well as team.

Program Specific Outcomes (PSO's)

Learners will be enriched with knowledge and be able to

PSO1 To infuse in the learner a spirit of inquiry into the fundamental aspects of the various core areas of Chemistry such as Electrochemistry, Chemical bonding & coordination compounds, reactions & reactivity of hydrocarbons.

PSO2 Demonstrate competence in problem solving skills in different areas of Chemistry

PSO3 gain the knowledge of the chemistry of the elements of p-block, Compare the properties of main group elements in the respective groups,Ions in aqueous medium & related effects on environment, Solid state , catalysis

PSO4 The student must understand the reactions of carbonyl compounds, amines, heterocyclic compounds & related reactions, the routes of synthesis of different types of materials and their characteristics.

S.Y.B.Sc. (CHEMISTRY)
(SEMESTER III)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESUSCH301	**Chemistry Paper 01**	**02**	**03**
	Unit I : Chemical Thermodynamics-II, Electrochemistry	**15 Lectures**	
	Unit II: Chemical Bonding	**15 Lectures**	
	Unit III : Reactions and reactivityof halogenated hydrocarbons, alcohols, phenols and epoxides	**15 Lectures**	
VESUSCH302	**Chemistry Paper 02**	**02**	**03**
	Unit I: Chemical Kinetics-II, Solutions	**15 Lectures**	
	Unit II : Selected topics on p block elements	**15 Lectures**	
	Unit III : Carbonyl Compounds	**15 Lectures**	
VESUSCH303	**Chemistry Paper 03**	**02**	**15**
	Unit I: Intorduction to Analytical Chemistry and Statistical Treatmentof analytical data	**15 Lectures**	**03**
	Unit II : Classical Methods of Analysis.	**15 Lectures**	
	Unit III : Instrumental Methods-I	**15 Lectures**	

S.Y.B.Sc. (CHEMISTRY)
(SEMESTER IV)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESUSCH401	**Chemistry Paper 01**	**02**	**03**
	Unit I Electrochemistry-II, Phase Equilibria	**15 Lectures**	
	Unit II Comparative Chemistry of the transition metals & Coordination Chemistry	**15 Lectures**	
	Unit III : Carboxylic acids and their derivatives, Sulphonic acids	**15 Lectures**	
VESUSCH402	**Chemistry Paper 02**	**02**	**03**
	Unit I Solid state, Catalysis	**15 Lectures**	
	Unit II Ions in aqueous medium & Usesand Environmental Chemistry of volatile Oxides and oxo-acids	**15 Lectures**	
	Unit III : Amines, Diazonium salts, Heterocyclic compounds	**15 Lectures**	
VESUSCH403	**Chemistry Paper 03**	**02**	
	Unit I Separation Techniques in Analytical Chemistry	**15 Lectures**	
	Unit II Instrumental Methods-II	**15 Lectures**	
	Unit III : Statistical Treatment of analytical data -II	**15 Lectures**	**06**
VESUSCHP5	**VESUSCHP402**		
VESUSCHP6	**VESUSCHP403**		

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: Chemistry Paper 01Course code: VESUSCH301

Objective: To understand and develop competence in use of Basic mechanics and Thermodynamics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1 Students will learn to calculate various thermodynamic parameters and application of clausius Clapeyron equation.

LO2 Students will be acquainted with various terms of electrochemistry , will be able to solve numericals of electrochemistry

LO3 Students will learn to calculate Lattice energy of compounds, hybridization of molecules.

LO4 Students will understand basic operations in Metallurgy and certain environmental aspects.

LO5 To learn different types of nucleophilic substitution reactions. To study the kinetics, mechanism & stereochemistry of these reactions. To study the nomenclature, synthesis, chemical reactions and uses of alcohols, phenols and epoxides.

LO6 To interpret M-C bond nature and reactivity order of organometallic compounds. To learn synthesis, importance of organometallic compounds

Course title: Chemistry Paper 01Course code: VESUSCH301

Unit no.	Details of topics	No of lectures
1	**1.1 Chemical Thermodynamics-II (8L)** 1.1.1 Free Energy Functions: Helmholtz Free Energy, Gibb's Free Energy, Variation of Gibb's Free energy with Pressure and Temperature. 1.1.2 Gibbs-Helmholtz equation, van't Hoff reaction isotherm and van't Hoff reaction isochore. (Numericals expected). 1.1.3 Thermodynamics of Open System: Partial Molal Properties, Chemical Potential and its variation with Pressure and Temperature, Gibb's Duhem equation. 1.1.4 Concept of Fugacity and Activity **1.2 Electrochemistry: (7L)** 1.2.1 Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. 1.2.2 Kohlrausch law of independent migration of ions. 1.2.3 Applications of conductance measurements: determination of degree of ionization and ionization constant of weak electrolyte, solubility and solubility product of sparingly soluble salts, ionic product of water. (Numericals expected).	15 Lectures

	1.2.4 Transference number and its experimental determination using Moving boundary method. (Numericals expected). Factors affecting transference number.	
2	**Unit-II Chemical Bonding** 2.1 Non-Directional Bonding (4L) 2.1.1 Ionic Bond: Conditions for the Formation of Ionic Bond. 2.1.2 Types of Ionic Crystals 2.1.3 Radius Ratio Rules 2.1.4 Lattice Energy, Borne-Lande Equation 2.1.5 Kapustinski Equation 2.1.6 Born-Haber Cycle and its Application 2.2. Directional Bonding: Orbital Approach. (6L) 2.2.1 Covalent Bonding the Valence Bond Theory- Introduction and basicPrinciples. 2.2.2 Interaction between two hydrogen atoms and the Potential energy diagramof the resultant system. 2.2.3 Corrections applied to the system of two hydrogen atoms- Formation of H2 2.2.4 Homonuclear diatomic molecules from He2 to Ne2 2.2.5 Resonance and the concept of Formal Charge; Rules for Resonance orCanonical structures. 2.2.6 Bonding in Polyatomic Species: The role of Hybridization. And types ofhybrid orbitals-sp, sp 2 , sp 3 , sp 3 d, sp2 d2 and sp2 d sp3 d2 . **2.4 Metallurgy, Types of metallurgies, ,General steps of metallurgy; Concentration of ore, calcinations, roasting,reduction and refining** 2.3 Molecular Orbital Theory (5L) 2.3.1. Comparing Atomic Orbitals and Molecular Orbitals. 2.3.2. Linear combination of atomic orbitals. to give molecular orbitalsLCAOMO approach for diatomic homonuclear molecules). 2.3.4. Wave mechanical treatment for molecular orbitals (H2 + and H2) 2.3.4 Molecular orbital Theory and Bond Order and magnetic property: with reference to O2,O2 + O2 - ,$O2^{2-}$	15 Lectures

3	**Unit III: Organic Chemistry** **3.1.1. Reactions and reactivity of halogenated hydrocarbons: [4L]** 3.1.1.**Alkyl halides:** Nucleophilic substitution reactions: S**N**1, S**N**2 and S**N**i mechanisms with stereochemical aspects and factors affecting nucleophilic substitution reactions-nature of substrate, solvent, nucleophilic reagent and leaving group. **3.1.2.Aryl halides:** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S**N**Ar)addition-elimination mechanism and benzyne mechanism. 3.1.2.**Organomagnesium and organolithium compounds: [3L]** Nomenclature, nature, type and reactivity of carbon-metal bond. Preparation using alkyl / aryl halide. Structure, stability and reactions with compounds containing acidic hydrogen, carbonyl compounds, CO2, cyanides and epoxides. **3.2 Alcohols, phenols and epoxides: [8L]** 3.2.1. **Alcohols:** Nomenclature, Preparation: Hydration of alkenes, hydrolysis of alkyl halides, reduction of aldehydes and ketones, using Grignard reagent. Properties: Hydrogen bonding, types and effect of	15 Lectures

	hydrogen bonding on different properties. Acidity of alcohols, Reactions of alcohols 3.2.2. **Phenols: Pr**eparation, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, Reactions of phenols, 3.2.3. **Epoxides:** Nomenclature, methods of preparation and reactions of epoxides: reactivity, ring opening reactions by nucleophiles (a) In acidic conditions: hydrolysis, reaction with halogen halide, alcohol, hydrogen cyanide. (b) In neutral or basic conditions: ammonia, amines, Grignard reagents, alkoxides.Applications of phenol.	

Course title: Chemistry Paper 02Course code: VESUSCH302 Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1 Students will be acquainted with different types of reaction , factors affecting reaction.

LO2 Students will be acquainted with ideal . non ideal solution and will also be able to apply Nernst equation to various system .

LO3 Students will know hybridisation in Boron compounds and extraction processes

LO4 Students will gain insight into the industrial process for Manufacturing of Ammonia

LO5 To know the trivial and IUPAC names of carbonyl compounds. To interpret the structure and study reactivity of carbonyl compounds. To study preparation of aldehydes and ketones.

LO6 To study reactions of aldehydes and ketones with their reaction mechanism. To study some selected name reactions and active methylene compounds reactions with their reaction mechanism.

Unit no.	Details of topics	No of lectures
1	**1.1 Kinetics-II (7L)** 1.1.1 Types of Complex Chemical reactions: Reversible or opposing, consecutive and parallel reactions (No derivations, only examples expected), Thermal chain reactions: H. and Br. reaction. (only steps involved, no kinetic expression expected). 1.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected). 1.1.3 : Introduction to electronic vibration and rotational energy levels &, Introduction to dipole moment, polarization of a bond, bond moment, molecular structure, Application to dipole moment. **1.2 Solutions: (8 L)** 1.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour	15 Lectures

	pressure-composition and temperature –composition curves of ideal and non-ideal solutions. Distillation of solutions.Lever rule. Azeotropes. 1.2.2 Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids with respect to Phenol-Water, Triethanolamine – Water and Nicotine –Water systems 1.2.3 Immiscibility of liquids- Principle of steam distillation. 1.2.4 Nernst distribution law and its applications, solvent extraction.	
2	**2. Selected topics on p block elements (15L)** 2.1 Chemistry of Boron compounds 2.1.1 Electron deficient compounds – BH3, BF3, BCl3 with respect to Lewisacidity and applications. 2.1.2 Preparation of simple boranes like diborane and tetraborane. 2.1.3 Structure and bonding in diborane and tetraborane (2e-3c bonds) 2.1.4 Synthesis of Borax. 2.2 Chemistry of Silicon and Germanium 2.2.1 Silicon compounds: Occurrence, Structure and inertness of SiO2 2.2.2 Preparation of structure of SiCl4 2.2.3 Occurrence and extraction of Germanium 2.2.4 Preparation of extra pure Silicon and Germanium 2.3 Chemistry of Nitrogen family 2.3.1 Trends in chemical reactivity - Formation of hydrides, halides, Comparative chemistry of carbides, nitrides of main group elements oxides of sulphur. 2.3.3 Synthesis of ammonia by Bosch – Haber process	15 Lectures
3	**Unit III: Organic Chemistry** **Carbonyl Compounds: [15L]** 3.1 Nomenclature of aliphatic, alicyclic and aromatic carbonyl compounds. Structure, reactivity of aldehydes and ketones and methods of preparation; Oxidation of primary and secondary alcohols using PCC, hydration of alkynes, action of Grignard reagent on esters, Rosenmund reduction, Gattermann – Koch formylation and Friedel Craft acylation of arenes 3.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions. 3.3 Reactions of aldehydes and ketones with NaHSO3, HCN, RMgX, alcohol, amine, phenyl hydrazine, 2,4-Dinitrophenyl hydrazine, LiAlH4 and NaBH4. 3.4 Mechanisms of following reactions: Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction. 3.5 Keto-enol tautomerism: Mechanism of acid and base catalysed enolization 3.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilised enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)	15 Lectures

Course title: Chemistry Paper 03Course code: VESUSCH303 Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1 Students will be acquainted with different types of reaction, factors affecting reaction.

LO2 Students will be acquainted with ideal. non ideal solution and will also be able to apply Nernst equation to various system.

LO3 .Students will know hybridisation in Boron compounds and extraction processes

LO4 Students will gain insight into the industrial process for Manufacturing of Ammonia

LO5 To know the trivial and IUPAC names of carbonyl compounds. To interpret the structure and study reactivity of carbonyl compounds. To study preparation of aldehydes and ketones.

LO6 To study reactions of aldehydes and ketones with their reaction mechanism. To study some selected name reactions and active methylene compounds reactions with their reaction mechanism.

Unit no.	Details of topics	No of lectures
1	Unit I- Introduction to Analytical Chemistry and Statistical Treatment of analytical data-I (15 L) **1.1. Role of Analytical Chemistry (9 L)** 1.1.1. Language of analytical chemistry: important terms and their significance in Analytical Chemistry. 1.1.2. Purpose of Chemical Analysis; Analysis Based (i) On the nature of information required: (Proximate, Partial, Trace, Complete Analysis) and (ii) On the size of the sample used (Macro, semi-micro and micro analysis) 1.1.3. Classical and Non-Classical Methods of Analysis; their types and importance. 1.1. Role of Analytical Chemistry (6 L) **1.2 Signal to Noise ratio** Sourses of noise in instrumental analysis,need for mazimization of signal to noise ratio,signal to noise enhancement types of method used (introduction only) (03L) **1.3. Results of Analysis.** (3L) 1.3.1. Errors in Analysis and their types 1.3.2. Precision and Accuracy in Analysis 1.3.3. Corrections for Determinate Errors (Problems including Numericals expected wherever required) **1.4 Analytical Method Validation (03L)** 1.4.1 Introduction and need for validation of a method	15 Lectures

	1.4.2Validation Parameters: Specificity, Selectivity, Precision, Linearity,Accuracy and Robustness	
2	**Unit II- Classical Methods of Analysis(15 L)** 2. **Classical Methods of Analysis**. (04L) 2.1. Titrimetric Methods 2.1.1. Terms involved in Titrimetric methods of analysis. Comparing volumetry and Titrimetry 2.1.2. The Conditions suitable for titrimetry 2.1.3. Types of titrimetry – Neutralisation (Acidimetry, alkalimetry), Redox,(Iodometry, Iodimetry,) Precipitation and Complexometric titrations andindicators used in these titrations 2.1.4. Tools of Titrimetry: Graduated glasswares and Calibration 2.2. Standard solutions (Primary and Secondary standards in Titrimetric) and Calculations in Titrimetry. 2.3. Neutralisation Titrations (04L) 2.3.1. Concept of pH and its importance in Neutralisation Titrations 2.3.2. End point and Equivalence point of Neutralisation titrations 2.3.3. Determination of End point by using i. Indicators causing colour change ii. Change in potential, (by potentiometry) iii. Change in conductance (by conductometry) 2.3.4. Construction of titration curve (on the basis of change in pH) of a titration of i. Strong acid-weak base ii. Strong base-weak acid 2.4. Gravimetric analysis (07L) 2.4.1. General Introduction to Gravimetry. 2.4.2. Types of Gravimetric Methods – 2.4.3. Precipitation Gravimetry: i. Steps involved in precipitation gravimetry analysis ii. Conditions for precipitation iii. Completion of precipitation, iv. Role of Digestion, Filtration, Washing, Drying Ignition of precipitate. 2.4 4 Applications of Gravimetry analysis **2.5 Precipitation titrations** Argentimetric Classical Methods of Analysis Volhards Method, Mhors method, Adsorption indicators –theory and applications (03L)	15 Lectures
3	Unit III: Instrumental Methods-I [15 L] 3. Basic Concepts in Instrumental methods (03) 3.1. Relation between the Analyte, Stimulus and measurement of change in the observable property. 3.2. Block Diagram of an Analytical instrument. 3.3. Types of Analytical Instrumental methods based on i. Optical interactions (eg. Spectrometry: uv-visible, Polarimetry)	15 Lectures

	ii. Electrochemical interactions (eg. Potentiometry, Conductometry,) iii. Thermal interactions (eg. Thermogravimetry) 3.4. Spectrometry (07 L) 3.4.1. Interaction of electromagnetic radiation with matter: Absorption and Emission spectroscopy 3.4.2. Basic Terms: Radiant Power, Absorbance, Transmittance, Monochromatic light, Polychromatic light, Wavelength of maximum absorbance, Absorptivity and Molar Absorptivity 3.4.3. Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression of Beer -Lambert's Law, Validity of Beer-Lambert's Law, Deviations from Beer-Lambert's Law (Real deviations, Instrumental deviations and Chemical deviations) (Numerical problems based on Beer-Lambert's Law) 3.4.4. Instrumentation for absorption spectroscopy: Colorimeters and Spectrophotometers 3.4.5. Block Diagrams for Single beam and Colorimeter, and Spectrophotometer (Principles, Construction and working-Details of Components expected i.e source, Sample holder , Filters/Monochromators, Detectors such as Photomultiplier tube) 3.4.6. Applications of UV-Visible Spectrophotometry (02 L) (a) Qualitative analysis such as Identification of functional groups in Organic compounds,Chromophores and Auxochrome,cis and trans isomers (b) Quantitative analysis by Calibration curve method and 3.4.7. Photometric Titrations: Principle, Instrumentation ,Types of Photometric titration Curves with examples. (03L)	

CHEMISTRY PRACTICALS **Semester 03**

LO1 students can validate Ostwald law for weak acid

LO2 Learner will be able to handle instruments like conductometer & potentiometer

LO3 Students will learn the purification of water by volumetric analysis.

LO4 Learner will be able to detect qualitatively presence of cations & anions in given mixture.

LO 5 The learner will be able to find the relation between concentration and Absorbance will be able to draw a calibration curve, use the slope of the calibration curve.

LO 6 The learner will be able to make derivatives of organic compounds and will be able to calculate the percentage yield.

Unit no.	Details of topics	No of lectures
1	**Paper I:** Physical Chemistry	

1. To verify Ostwald's dilution law for weak acid conductometrically.
2. To determine dissociation constant of weak acid conductometrically.
3. To determine the critical solution temperature (CST) of phenol - Water System.
4. Determination of energy of activation of acid catalyzed hydrolysis of methyl acetate.
5. To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentrations of the reactants
6. To determine solubility of sparingly soluble salts (any two) conductometrically

Identification of cations in a given mixture and Analytically separating them [From a mixture containing not more than two of the following: Pb(II), Ba(II), Ca(II), Sr (II), Cu(II), Cd(II), Mg(II), Zn(II), Fe(II), Fe(III), Ni(II), Co(II) Al(III), Cr(III)]

Paper II

1. Estimation of total hardness
2.Conductometric titration: Estimation of given strong acid by conductometric titration with strong base and calculation of % error.
3..Organic Chemistry Short organic preparation and their purification: Use 0.5-1.0g of the organic compound.
Purify the product by recrystallization. Report theoretical yield, percentage yield and melting point of the purified product. Preparation of:
1. Cyclohexanone oxime from cyclohexanone.
2. Glucosazone from dextrose or fructose 3. Tribromoaniline from aniline.
4. β-Naphthylbenzoate
5. m-Dinitrobenzene from nitrobenzene
6. Phthalic anhydride from phthalic acid by sublimation
7. Acetanilide from aniline
8. p-Bromoacetanilide from acetanilide
9. Iodoform from acetone

Paper III

1.Tools of Analytical Chemistry-:
a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating
funnels.
b) Weighing tools such as two pan balance and monopan balance, digital
balances:
c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,
d) Drying Devices: Hot Air Oven, Microwave Oven, Descicators, Vacuum
descicators

	e) Monochromators, Filters, Sample holders, Prisms, Diffraction Gratings, Photoemissive cells, Photomultiplier tubes (The learner should draw diagrams and write-ups providing uses, care and maintenance of the items mentioned in (a) and principle, construction and uses of items (b) to (e) in his journal. 2. Gravimetric estimation of Nickel (II) as Ni-DMG and calculation of % error. (The learner is expected to know the role of the various reagents/chemicals used In the estimation, various steps are involved. They should write the complete and Balanced chemical reaction for the formation of the Ni(DMG)2 complex. 3. Colorimetric Determination of Copper Ions in given Solution by using calibration curve method and calculation of % error. (and compare it with the calculated slope. They are also expected to state the error estimate of their results). 4. Determination of buffer capacity of acid buffer and basic buffer. (The learner is expected to learn the use pH meter, standardization of pH meter, use of Henderson's equation and calculation of buffer capacity) 5. Estimation of Aspirin 6. Gravimetric estimation of barium ions using K2CrO4 as precipitant calculation of % error. (The learner is expected to learn the skills of using the counterpoise technique used in this gravimetric estimation, Using counterpoise method whatman No.42 for filtration. In such a case no incineration or use of silica crucible is required. They are also expected to state the error estimate of their results)	

Course title: Chemistry Paper 01Course code: VESUSCH401 Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1 Learner can evaluate thermodynamic parameters
LO2 Learner will know importance of Phase diagram
LO3 Learners will be able to know the properties of transition elements and

coordination compounds.

LO4 Learner can go through industrial process of extraction of silver

LO5 To know the method of naming carboxylic acids and sulphonic acids. To understand the basic properties of carboxylic acids and sulphonic acids. To learn various methods of preparation of carboxylic acids and sulphonic acid

LO6 To study the comparative acidity of carboxylic acid and sulfonic acids. To study the mechanism of various reactions of carboxylic acid and sulfonic acids.

Unit no.	Details of topics	No of lectures
1	**Unit I: Physical Chemistry** 1.1 Electrochemistry-II: (8 L) 1.1.1 Electrochemical conventions, Reversible and irreversible cells. 1.1.2 Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). 1.1.3 Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) 1.1.4 Calculation of equilibrium constant from EMF data. (Numericals expected) 1.1.5 Reference electrodes and indicator electrodes 1.1.6 pH determination using hydrogen electrode and quinhydrone electrode.(Numericals expected) – 1.2 Phase Equilibria: (7L) 1.2.1 Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. 1.2.2 Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. (numerical expected) 1.2.3 Phase diagrams of one-component systems (water and sulphur). 1.2.4 Two component systems involving eutectics, (lead-silver system)	15 Lectures
2	**Unit II: Inorganic Chemistry** 2.1 Comparative Chemistry of the transition metals (9 L) 2.1.1 Position in the periodic table; Natural occurrence principal ores and minerals. 2.1.2 Significance of special stability of d0 , d5 and d10 leading to variable oxidation states; Unusual oxidation states and their stabilities in aqueous solutions (with special reference to vanadium, and chromium.)	15 Lectures

	2.1.3 Origin of colour for transition metals and their compounds: such as reflectivity, surface coatings, particle size, packing density for metals and nature of d-orbitals, number of electrons in the d-orbitals, geometry, and ability for charge transfer). 2.1.4 Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected); Reasons for quenching of orbital moments. 2.1.5 Extraction of Silver & special properties of compounds viz., colour, properties chemical reactions, physical properties and uses / Applications of MnO_2, $KMnO_4$, $K_2Cr_2O_7$, $K_4[Fe(CN)_6]$ $K_3[Fe(CN)_6]$, K_2CrO_4. **2.2 Coordination Chemistry: (6 L)** 2.2.1 Introduction to Chemistry of Coordination Compounds i. Historical perspectives: Early ideas on coordination compounds ii. Basic terms and nomenclature. iii. Types of ligands iv. Isomerism: General Types with special reference to stereoisomerism of coordination compounds (C.N=6) v. Evidence for the formation of coordination compounds 2.2.2. Theories of coordination compounds i. Werner's Theory of coordination compounds ii. Effective atomic number rule iii. Eighteen electron Rule 2.2.3. Nature of the Metal-Ligand Bond: i. Valence Bond Theory; Hybridisation of the central metal orbitals-sp3 , sp3d3 /d3 s sp3 d2 /d2 sp3 , sp2d ii. Inner and outer orbital complexes of (suitable examples of Mn(II) Fe(II),Fe(III),Co(II)/Co(III), Ni(II), Cu(II) Zn(II) complexes with ligands like aqua, ammonia CN^- and halides may be used) iii. Limitations of V.B.T 2.2.4. Application of coordination compounds.	
3	Unit III: Organic Chemistry 3.1 Carboxylic Acids and their Derivatives :(11 Lectures) 3.1.1. Nomenclature, structure and physical properties, acidity of carboxylic acids,effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. 3.1.2. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene,carbonation of Grignard and hydrolysis of nitriles. 3.1.3. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylicacids with $LiAlH_4$, diborane, Hell-Volhard-Zelinsky reaction,Conversion ofcarboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. 3.1.4. Mechanism of nucleophilic acyl substitution and acid-catalysed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.	15 Lectures

	3.1.5. Mechanism of Claisen condensation and Dieckmann condensation.Sulphonic acids: [4L] Nomenclature, preparation of aromatic sulphonic acids bysulphonation of benzene (with mechanism), toluene and naphthalene Reactions: Acidity of arene sulfonic acid, Comparative acidity of carboxylic acid and sulfonic acids, Salt formation, desulphonation , Reaction with alcohol, phosphorouspentachloride, IPSO	

Course title: Chemistry Paper 02Course code: VESUSCH402

LO1 (Physical chem LO)
LO2 (Physical chem LO)
LO3 A learner can gain knowledge of acidity and basicity of ions can be calculated
LO4 Learner will know Minamata and Bhopal gas tragedy a case study
LO5 To know the trivial & IUPAC names of aliphatic and aromatic amines. To understand the effect of substituent on basicity of aliphatic and aromatic amines.
LO6 To study diazonium salts preparation and their reactions/synthetic application. To study classification, nomenclature, electronic structure, aromaticity in 5-membered and 6-membered rings containing one heteroatom.

Unit no.	Details of topics	No of lectures
1	**Unit-I : Physical Chemistry** **1.1 Solid state (7L)** Recapitulation of laws of crystallography and types of crystals 1.1.2 Characteristics of simple cubic, face centered cubic and body centered cubic systems, interplanar distance in cubic lattice (only expression for ratio of interplanar distances are expected) 1.1.3 Use of X-rays in the study of crystal structure, Bragg's equation (derivation expected), X-rays diffraction method of studying crystal lattice structure, structure of NaCl and KCl. Determination of Avogadro's number (Numericals expected) **1.2 Catalysis: (8 L)** 1.2.1 Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation 1.2.2 Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. 1.2.3 Mechanisms and kinetics of enzyme catalyzed reactions (Michaelis-Menten equation) 1.2.4 Effect of particle size and efficiency of nanoparticles as catalyst.	15 Lectures
2	**Unit 02 Inorganic Chemistry** 2 Ions in aqueous medium [8L] 2.1. Acidity of Cations and Basicity of Anions i. Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius.	15 Lectures

	ii. Latimer Equation. Relationship between pKa, acidity and z2 /r ratios of metal ions graphical Presentation iii. Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples iv. Hydration of Anions; Effect of Charge and Radius; Hydration of anions concept, diagram classification on the basis of basicity 2.2. Uses of volatile Oxides and oxo-acids[7L] i. Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid ii. Uses and environments aspects of these acids. ii:Green chemistry as an alternative tool for reducing pollution with reference to Case studies Minamata and Bhopal Gas tragedy.	
3	**Unit III: Organic Chemistry** **Nitrogen containing compounds and heterocyclic compounds: (7 Lectures)** **3.1 Amines:** Nomenclature, effect of substituent on basicity of aliphatic and aromatic amines; 3.1.1. Preparation: Reduction of aromatic nitro compounds using catalytic hydrogenation,chemical reduction using Fe-HCI, Sn-HCl, Zn-acetic acid, reduction of nitriles, ammonolysis of halides, reductive amination , Hofmann bromamide reaction. 3.1.2. Reactions- Salt Formation, N-acylation, N-alkylation, Hofmann's exhaustive methylation (HEM),Hofmann-elimination reaction, reaction with nitrous acid, carbylamine reaction, Electrophilic substitution in aromatic amines: bromination, nitration and sulphonation. **3.2 Diazonium Salts and** Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Replacement of diazo group by -H,-OH. Azo coupling with phenols, naphthols and aromatic amines, reduction of diazonium salt to aryl hydrazine and hydroazobenzene **3.3 Heterocyclic Compounds: (8 Lectures)** 3.3.1. Classification, nomenclature, electronic structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; 3.3.2. Synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, and Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis) 3.3.3. Reactivity of furan, pyrrole and thiophene towards electrophilic substitution reactions on the basis of stability of intermediate and of pyridine on the basis of electron distribution. Reactivity of pyridine towards nucleophilic substitution on the basis of electron distribution. 3.3.4. Reactions of furan, pyrrole and thiophene: halogenation, nitration, sulphonation, Vilsmeier-Haack reaction, Friedel-Crafts reaction. Furan: Diels-Alder reaction, Ring opening. Pyrrole: Acidity and basicity of pyrrole. Comparison of basicity of pyrrole and pyrrolidine. 3.3.5. Pyridine: Basicity. Comparison of basicity of pyridine, pyrrole and piperidine. Sulphonation of pyridine (with and without catalyst), reduction and action of sodamide (Chichibabin reaction).	15 Lectures

	azo-coupling for synthesis of Dyes	

Course title: Chemistry Paper 03Course code: VESUSCH403

Unit no.	Details of topics	No of lectures
1	**Unit-I : Analytical Chemistry** Unit –I -Methods of separation 1. Separation Techniques in Analytical Chemistry (02 L) 1.1. An Introduction to Analytical Separations and its importance in analysis. 1.2. Estimation of an analyte without effecting separation. 1.3. Types of separation methods 1.3.1. Based on Solubilities (Precipitation, Filtration Crystallisation) 1.3.2. Based on Gravity- Centrifugation 1.3.3. Based on volatility-Distillation ; 1.3.4. Based on Electrical effects-Electrophoresis 1.3.5. Based on retention capacity of a Stationary Phase -Chromatography 1.3.6. Based on distribution in two immiscible phases-Solvent Extraction; 1.3.7. Based on capacity to exchange with a resin-Ion Exchange; 1.4. Electrophoresis: Principles, Basic Instrumentation,Working and Application in separation of biomolecules like enzymes and DNA.(02L) 1.5. Solvent extraction (06 L) 1.5.1. Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient. 1.5.2. Conditions of extraction: Equilibration time, Solvent volumes, temperature, pH. 1.5.3. Single step and multi step extraction, Percentage extraction for single step and multistep extraction. Separation factor. 1.5.4. Batch and continuous extraction 1.6. Chromatography : (05L) 1.6.1. Introduction to Chromatography 1.6.2. Classification of chromatographic methods based on stationary and mobile phase 1.6.3. Paper Chromatography: Principle, techniques and applications of Paper Chromatography in separation of cations. 1.6.4. Thin layer Chromatography Principle, technique and Applications in determining the purity of a given solute; following progress of a given reaction.	15 Lectures

2	**Unit –II - Instrumental Methods-II** 2.1.Potentiometry: (05 L) 2.1.1.Principle. 2.1.2.Role of Reference and indicator electrodes 2.1.3.Applications in Neutralisation reactions with reference to the titration of a Strong acid against a Strong Base (using quinhydrone electrode) 2.1.4.Graphical methods for detection of end points 2.2.pH metry: (04 L) 2.2.1.Principle 2.2.2.Types of pH meters. 2.2.3. Principle, Construction Working and Care of Combined Glass electrode. 2.2.4. Applications in Titrimetry (Strong acid-Strong Base) biological and environmental analysis. 2.3.Conductometry: (06 L) 2.3.1.Principle 2.3.2.Conductivity cell its construction and care 2.3.3.Applications in Neutralisation Titrimetry with respect to i.Strong Acid-Strong Base ii.Strong Acid-Weak Base iii.Strong Base-weak Acid iv.Weak Acid- Weak Base. 2.3.4. Advantages & limitations of conductometric titrations.	15 Lectures
3	**Unit 03 Analytical Chemistry** Unit III- Statistical Treatment of analytical data --II 3.1. Nature of Indeterminate Errors: (03L) 3.1.1. The true and acceptable value of a result of analysis 3.1.2. Measures of central tendency: mean, median. mode, average 3.1.3. Measures of dispersion: Absolute deviation, relative deviation, relative average deviation, standard deviation,(s,sigma) variance, coefficient of variation 3.2. Distribution of random errors: (02L) 3.2.1.Gaussian distribution curve. 3.2.2.Equation and salient features of Gaussian distribution curve 3.3. Concept of Confidence limits and confidence interval and its computation using (03 L) (i)Population standard deviation (ii)Student's t test (iii)Range 3.4.Criteria for rejection of doubtful result (02 L) (i)2.5 d rule	15 Lectures

	(ii)4.0 d rule (iii)Q test 3.5. Test of Significance (02 L) (i)Null hypothesis (ii)F-test (Variance ratio test) 3.6. Graphical representation of data and obtaining best fitting straight line (03 L) (a)For line passing through origin (b)For line not passing through origin [Numerical problems wherever possible, expected]	

CHEMISTRY PRACTICALS **Semester 04**

LO1 Learner can handle instruments like potentiometer & conductometer
LO2 Students will be able to determine rate constants and will be able to compare the various rates.
LO3 Students will also learn to plot the graph.
LO4 Learner will able to learn and perform microscale technique in inorganic preparations
LO5 The learner will able to perform the different test for organic compounds
LO6 Chromatography a simple tool can be performed in lab to know process of detection

Unit no.	Details of topics	No of lectures
	Paper I: Physical Chemistry 1. To determine standard EMF andthe standard free energy change of Daniel cell potentiometrically 2. To determine the amount of HCl in the given sample potentiometrically. 3. Compare the strengths of HCl and H2SO4 by studyingkinetics of acid hydrolysis of methyl acetate. 4. Inorganic preparation –a. Nickel dimethylglyoxime using microscale method. b. Tris (ethylene diamine) nickel (II) thiosulphate. . 5 Conductometric titration: Estimation of given weak acid by conductometric with strong base and calculation of %error.. 6. Inorganic salt – Calcium or magnesium oxalate using PFHS technique **Paper II:**	

Organic Chemistry Qualitative Analysis of bi-functional organic compounds on the basis of

1. Preliminary examination
2. Solubility Test
3. Detection of elements C, H, (O), N, S, X.
4. Detection of functional groups
5. Determination of physical constants (M.P/B.P)

(Solid or liquid Compounds containing not more than two functional groups from among the following classes may be given for analysis to be given: Carboxylic acids, phenol, carbohydrates, aldehydes, ketones, ester, amides, nitro, anilides,amines, alkyl and aryl halides)

Paper III

Paper III Elective

(Basics in analytical Chemistry)

1. Tools of Analytical Chemistry-II

a. Filtration Flasks, Funnels, Separating Funnels, Distillationapparatus, Vacuum Distillation assembly, Centrifuge machine, Electrophoresis apparatus.

b. Development chamber for chromatography

c. Electrodes like Reference Electrodes and Indicator Electrodes (with respect to care and maintenance.)

d. Conductivity cell (with respect to care and maintenance.)

e. Combined Glass electrode (with respect to care and maintenance.)

f. Types of Salt Bridges and preparation of any one or use of salt bridge, its effect on the potential of a given electrode/cell

(The learner should draw diagrams and write-ups providing uses of the items mentioned in a, b) and Principle, Construction care and Uses of items (c) to (f) in hisjournal.)

2. Paper chromatography: Separation of cations like Fe(III), Ni(II) andCu(II) in a sample.

3..To determine Partition coefficient between iodine and carbon tetrachloride (The learner is expected to learn the technique of solvent extraction by using separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)

4. 5. Estimation of Fe(II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner isexpected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine the end point by plotting a graph. They are also expected to state the error estimate of their results).

6. Gravimetric estimation of Sulfate as $BaSO_4$ and calculation of % error. (The learner is expected to write a balanced chemical reaction,

	need for digestion of the precipitate and the skill required to carry out the incineration and to estimate the % error.) 7. Estimation of given strong acid by with strong base via pHmetry and calculation of % error.	

References

REFERENCES _THEORY

Reference Books:

Unit I: Physical Chemistry

1. Atkins P.W. and Paula J.de, Atkin's Physical Chemistry, 10th Ed., Oxford University 12 Press (2014).
2. Ball D.W., Physical Chemistry, Thomson Press, India (2007).
3. Castellan G.W., Physical Chemistry, 4th Ed., Narosa (2004).
4. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
5. Engel T. and Reid P., Physical Chemistry, 3rd Ed., Pearson (2013).
6. Peter A. and Paula J. de., Physical Chemistry, 10th Ed., Oxford University Press (2014).
7. McQuarrie D.A. and Simon J.D., Molecular Thermodynamics, Viva Books Pvt.Ltd.,New Delhi (2004).
8. Levine I.N., Physical Chemistry, 6th Ed., Tata Mc Graw Hill (2010).
9. Metz C.R., 2000 Solved Problems in Chemistry, Schaum Series (2006).
10. Mortimer R.G., Physical Chemistry, 3rd Ed., Elsevier: NOIDA, UP (2009).
11. Banwell C.N., Fundamentals of Molecular Spectroscopy, 4th Ed., Tata McGraw Hill (1994).
12. K.L. Kapoor, A Textbook of Physical Chemistry, Macmillan (2000).

Unit II: Inorganic Chemistry

1. Puri, Sharma and Kalia, Milestone publishers, Principles of Inorganic Chemistry
2. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS,
3. Cotton and Wilkinson, Advanced Inorganic Chemistry, 3rd. Edition.
4. D. F. Shriver and P. W. Atkins, Inorganic chemistry, 3rd edition, Oxford University Press (1999)
5. Per Jensen and Philip R. Bunker , Fundamentals of Molecular Symmetry, Series in Chemical Physics, Taylor & Francis Group
6. J. S. Ogden, Introduction to Molecular Symmetry, Oxford University Press
7. Satya Prakash, G.D.Tuli, R.D. Madan,Advanced Inorganic Chemistry.S. Chand & Co Ltd
8. C. N. R. Rao Advances in Solid State Chemistry

9. R. Gopalan, Inorganic Chemistry for Undergraduates, Universities Press India.

10. Greenwood, N.N. and Earnshaw, Chemistry of the Elements, Butterworth Heinemann. 1997.

Unit III: Organic Chemistry

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India)Pvt Ltd. (Pearson Education).2012
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd.(Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley:London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
6. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

REFERENCES _PRACTICAL

Reference Books
Reference Books for Practicals:
Unit I:

1. Khosla B.D., Garg V.C. and Gulati A., Senior Practical Physical Chemistry, R. Chand and Co., New Delhi (2011).
2. Garland C. W., Nibler J.W. and Shoemaker D.P., Experiments in Physical Chemistry,
8th Ed., McGraw-Hill, New York (2003).
3. Halpern A.M. and McBane G.C., Experimental Physical Chemistry, 3rd Ed., W.H. Freeman and Co., New York (2003).
4. Athawale V.D. and Mathur P., Experimental Physical Chemistry, New Age International, New Delhi (2001)

Unit II:

1. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)

Unit III:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). Mann, F.G. &

Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
4. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
1.

Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part. Practical Examination will consist of End Semester examination.

Students will have to score 40% of marks in Internal assessment as well as End Semester examination to pass the course.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment: It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

A. Theory - Internal assessment 25% 25 marks

Sr No	Evaluation type	Marks
1.	- Class Test (multiple choice questions / objective)	15
2.	- Active participation in routine class activity OR Project based learning activities (Group Research/ Case studies/ Reports / Presentations/Assignments / Skit / Poster / etc.),	10

B. Theory - External examination - 75% 75 marks

Semester End Theory Assessment

Duration - Each paper shall be of 2.5hours duration.

1. Theory question paper pattern:-
    a. There shall be FIVE compulsory questions.
    b. Question No 01 and Question No 05 will be based on Unit 01, 02 and 03
    c. Question No 01 will contain MCQ (any twelve out of eighteen) and True or False (any three out of six)
    d. Question No 2, 3 and 4 will be based upon Unit 01, Unit 02 and Unit 03 respectively.
    e. Question No 5 will contain Six questions. (Unit 1+Unit 02+Unit 03 each Two Questio

For Paper 01 and 02(Physical, Inorganic and Organic)

Question no.	Details	Marks
Q1.	A] Fill in the blanks/ MCQ Attempt any twelve out of eighteen B] True or False Attempt any three out of six Question No 01 will be based on Unit 01, 02 and 03	**12** **3**
Q2.	**(Unit 01 Physical Chemistry)**	15M
	Attempt **any three of the five** A) /B) / C) / D) / E)	
Q3.	**(Unit 02 Inorganic Chemistry)**	15M
	Attempt **any three of the five** A) /B) / C) / D) / E)	
Q4	**(Unit 03 Organic Chemistry)**	15M
	Attempt **any three of the five** A) /B) / C) / D) / E)	
Q5	**Attempt any three of the following Six**	15M
	A) /B) / C) / D)/ E) / F)	

For Paper 03 Analytical Chemistry

Question no.	Details	Marks
Q1.	A] **Fill in the blanks/ MCQ** Attempt any twelve out of eighteen B] **True or False** Attempt any three out of six Question No 01 will be based on Unit 01, 02 and 03	**12** **3**
Q2.	**(Unit 01)**	15M
	Attempt **any three of the five** A) /B) / C) / D)/ E)	
Q3.	**(Unit 02)**	15M
	Attempt **any three of the five** A) /B) / C) / D)/ E)	

Q4	**(Unit 03)**	15M
	Attempt **any three of the five** A) /B) / C) / D)/ E)	
Q5	**Attempt any three of the following Six**	15M
	Attempt **any three of the five** A) /B) / C) / D)/ E)	

C. Semester End Practical Assessment **50 marks**

	Section 1 Based on Paper 1	**50 Marks**
A	Any one experiment	35
B	Viva	10
C	Journal	05
	Section 2 Based on Paper 2	**50 Marks**
A	Any one experiment	35
B	Viva	10
C	Journal	05

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

SEMESTER III

Course	VESUSCH301	VESUSCH302	VESUSCH303	Grand Total
Theory	100	100	100	300
Practicals	50	50	50	150

SEMESTER IV

Course	VESUSCH401	VESUSCH402	VESUSCH403	Grand Total
Theory	100	100	100	300
Practicals	50	50	50	150