Punyashlok Ahilyadevi Holkar Solapur University, Solapur

NAAC Accredited-2022
'B++' Grade (CGPA 2.96)

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: CHEMISTRY

Name of the Course: B.Sc. I (Sem.–I & II)

(Syllabus to be implemented from June 2022)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

SYLLABUS FOR B. Sc. – I (CHEMISTRY)

CHOICE BASED CREDIT SYSTEM (CBCS) SYLLABUS

Structure of the Course:

- Structure of B.Sc. course in faculty of science has total of 06 semesters for 3 years.
- B.Sc.-I comprises of total two semesters. Each semester will have **two** theory papers of 40 marks for university examination and 10 marks for internal examination for each paper.
- Practical examination will be conducted at the end of academic year
  The weightage of practical is of 80 marks for university practical examination and 20 marks for internal practical examination.
- The titles and marks distribution for each paper are as under.

Semester	Paper No.	Title of Paper	Total Lectures	Examination			Total Credit
				Univ. Exam	Internal Exam	Total Marks	
Semester I	I	Physical Chemistry	30	40	10	50	02
	II	Inorganic Chemistry	30	40	10	50	02
Semester II	III	Organic Chemistry	30	40	10	50	02
	IV	Analytical Chemistry	30	40	10	50	02
	I	Chemistry Practical	04 hr /Week	80	20	100	04

- **University Examination**
  1. Theory Paper I : 40 Marks
  2. Theory Paper II : 40 Marks
  3. Theory Paper III : 40 Marks
  4. Theory Paper IV : 40 Marks
  5. Practical : 80 Marks

Chemistry Practical paper has 80 marks for university practical examination. Duration of practical examination is **one day**. There will be two practicals, (P+I/ I+O/O+A/A+P) of 30 marks each. Nature of practical question paper will be as follows,

Q. 1. Solve any TWO from the given below: (30+30) Marks
- Physical Chemistry experiment : 30 marks
- Inorganic Chemistry experiment : 30 marks
- Organic Chemistry experiment : 30 marks
- Analytical Chemistry experiment : 30 marks

Q. 2. Certified Journal : 10 Marks

Q. 3. Oral : 10 Marks

Total Marks :80 marks

- **Continuous Internal Assessment :**
  1) Each theory paper has 10 marks for internal examination.
  2) Practical paper has 20 marks for internal examination.

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SEMESTER-I

PAPER –I (Physical Chemistry)

Learning Objectives:

- To acquire knowledge about rates of chemical reactions and distinguishing the reaction of a different order and their characteristics.
- To get information about thermodynamics and its process.
- To learn mathematical concepts such as graphical representation, derivative, and integration.
- To achieve knowledge of the gases states such as ideal and non-ideal gases, isotherm, and liquefaction of gases.

Course Outcome: After successful completion of this course, students are expected to:

- Understand the significance of rates of chemical reactions.
- Able to understand second law thermodynamics and Carnot cycle and its efficiency.
- Able to the knowledge of mathematical concepts.
- Also, get a better understanding gaseous state.

(Total Credits: 2; Contact hrs: 30) **Marks: 50 (40+10)**

Unit I **(Contact hrs: 15)**

1. Mathematical Concepts **(Contact hrs: 04)**

1.1 Graphical representation: Graph paper, co-ordinates of a point, equation of straight line and intercept, plotting of graph based on experimental data.

1.2 Derivative: Rules of differentiation (without proof) pertaining to algebraic and exponential functions. Examples related to chemistry.

1.3 Integration: Types of integration, Rules of Integration (without proof) pertaining to algebraic and exponential functions. Examples related to chemistry. (Numerical Problems not expected)

2. Gaseous State: **(Contact hrs: 11)**

2.1 Ideal and Non ideal gases, Deviation from ideal behaviour. (Only Boyle's law) , Causes of deviation from ideal behaviour, van der Waal's equation, explanation of real gas behaviour by van der Waal's equation.

2.2 Critical Phenomena : PV-Isotherms of real gases (Andrew's isotherms), continuity of state, Relationship between critical constants and van der Waal's constants.

2.3 Liquefaction of gases, Joule-Thomson effect.

2.4 Numerical Problems

Unit II **(Contact hrs: 15)**

1. Chemical Kinetics **(Contact hrs: 11)**

1.1 Chemical Kinetics and it's scope, Rate of reaction, Definition and units of rate constant. Factors affecting rate of reaction, Concentration, pressure, temperature and catalyst: with example of Ammonia synthesis by Haber's Process.
1.2 Order and Molecularity of reaction.
1.3 First order reaction: Derivation of Rate constant, Characteristics of first order reaction,
Example: Decomposition of N_2O_5
1.4 Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Characteristics of Second order reaction, Example: Reaction between $K_2S_2O_8$ and KI
1.5 Pseudo-uni-molecular reaction, Example: Hydrolysis of methyl acetate in presence of acid.
1.6 Numerical Problems

2. Thermodynamics: **(Contact hrs: 04)**
2.1 Spontaneous and non spontaneous processes, Second law of thermodynamics and it's statements.
2.2 Carnot's Theorem (Heat engine), Carnot cycle and its efficiency.
2.3 Numerical Problems

Reference Books:

1) Mathematical preparation of Physical Chemistry : F. Daniel Mc-Graw Hill Book Com.

2) Elements of Physical Chemistry : S. Glasstone and D. Lewis (D. Van Nostrand Co. Inc)

3) Physical Chemistry : W. J. Moore (Orient Longman)

4) Principles of Physical Chemistry :Maron Prutton

5) University Chemistry : B. H. Mahan (Addision - Weseley Publ. Co.)

6) Chemistry Principle &Applications : P.W. Atkins, M. J. Clugsto, M.J. Fiazer, R. A. Y. Jone (Longman)

7) Physical Chemistry : G. M. Barrow (Tata Mc-Graw Hill)

8) Essentials of Physical Chemistry : B. S. Bahl& G.D. Tuli (S. Chand)

9) Physical Chemistry : A. J. Mee.

10) Physical Chemistry :Alberty R. A. and Silbey, R.J.John Wiley and Sons, 1992

11) Principles of Physical Chemistry :B. R. Puri, L.R. Sharma and M.S.Patania, S.L.N. Chand & Co. 1987

12) Basic Chemical Thermodynamics : V. V. Rao.

13) University General Chemistry : CNR. Rao (McMillan)

14) Physical Chemistry Through problems : Dogra and Dogra (Wiley Eastern Ltd.,)

15) Physical Chemistry : S. Glasstone.

16) Physical Chemistry(3rd Edition) - Gilbert W. Castilian, Narosa Publishing House,1985

17) Chemical Kinetics by K. J. Laidler, Tata McGraw Hill Publishing Co., New Delhi.

18) Kinetics and Reaction Mechanisms by Frost and Pearson, Wiley, New York.

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SEMESTER-I

PAPER –II (Inorganic Chemistry)

Learning Objectives:

- To acquire knowledge of quantum mechanics, shapes of orbitals and periodic properties.
- To gain knowledge of ionic bonding and ionic solids.
- To proper understanding of covalent bonding using VBT and MOT approach.

Course Outcome: After the end of the course, the students can understand:

- The atomic structure and periodic properties and trends; types of chemical bonding.
- Key knowledge of ionic bonding and different parameters of crystal structure.
- The basic knowledge of the VBT and MOT acquire with various examples.

(Total Credits: 2; Contact hrs: 30) **Marks: 50 (40+10)**

Unit I **(Contact hrs: 15)**

1. Atomic Structure and periodic properties **(Contact hrs: 07)**

1.1 Atomic Structure

a) What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2 (Derivation not expected)

b) Quantum numbers

c) Shapes of s, p, d orbitals

d) Aufbau and Pauli's exclusion principle, Hund's rule of maximum multiplicity Stability of half-filled and completely filled orbitals, exchange energy

e) General electronic configuration of s and p block elements

1.2 General Characteristics of s and p block elements w.r.t. Atomic and Ionic radii, Ionization energy, Electron affinity, Electronegativity, Reactivity, Melting and Boiling point

1.3 Types of chemical bonding: Ionic, Covalent, Co-ordinate, Metallic, Hydrogen bonding and Weak Chemical Forces: van der Waal's forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions (Illustration with suitable examples and its implications).

2. Chemical bonding and Ionic Solids **(Contact hrs: 08)**

2.1 Ionic Bonding:

a) Formation of ionic bond, Energetics of ionic bonding: Ionisation potential, Electron affinity and Lattice energy.

b) Characteristics of ionic compounds.

c) Born-Haber Cycle for Alkali metal halide (NaCl)

d) Fajan's rules

2.2 Radius ratio and crystal structure.

a) Definition: Radius ratio (r^+ / r^-), Coordination number, Stoichiometry and unit cell.
b) Concept and calculation of radius ratio (r^+ / r^-) for ionic solid with octahedral geometry.
c) Radius ratio effect on geometry
d) Crystal structure of NaCl and CsCl: unit cell, radius ratio, coordination number and stoichiometry.

Unit-II **(Contact hrs: 15)**

1. Covalent bonding: Valence Bond Theory (VBT) **(Contact hrs: 07)**

1.1 Valence Bond Theory: Heitler–London Theory and Pauling-Slater Theory: Merits and Demerits
1.2 Need of Hybridization with respect to $BeCl_2$, BF_3, $SiCl_4$
1.3 Types of hybridization and shapes of simple inorganic molecules: PCl_5,SF_6
1.4 Valence Shell Electron Pair Repulsion (VSEPR) Theory w.r.t. NH_3, H_2O

2. Covalent bonding: Molecular Orbital Theory (MOT) **(Contact hrs: 08)**

2.1 Atomic and Molecular orbitals.
2.2 L.C.A.O. Principle
2.3 Bonding, Antibonding and Nonbonding Molecular orbitals.
2.4 Conditions for successful overlap
2.5 Different types of overlap (s-s, s-p_x, p_x - p_x and p_y- p_y or p_z- p_z)
2.6 Energy level sequence of molecular orbitals for n = 1 and n = 2
2.7 M. O. Diagrams for: a) Homonuclear diatomic molecule. H_2, Li_2, Be_2, C_2, N_2 and O_2
b) Heteronuclear diatomic molecules CO and NO w.r.t. bond order stability and magnetic properties.

Reference Books:

1) Advanced Inorganic Chemistry - Cotton and Wilkinson
2) Inorganic Chemistry - J. E. Huheey
3) Concepts and models of Inorganic Chemistry - Douglas & Mc-Daniel
4) Principles of Inorganic Chemistry - Puri, Sharma
5) New Concise Inorganic Chemistry - (ELBS) - J. D. Lee
6) Text book of Inorganic Chemistry - P. L. Soni
7) Advanced Inorganic Chemistry - Satyaprakash, Tuli, Basu
8) Theoretical Principles of Inorganic Chemistry - G. S. Manku
9) Principles of Inorganic Chemistry - Puri, Sharma & Kalia
10) Inorganic chemistry: Principles of structure and reactivity – J. E. Huheey
11) Advanced Inorganic Chemistry, Vol. I – Gurudeep Raj
12) A New Guide to Modern Valency Theory- G. J. Brown

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SEMESTER-II
PAPER III: Organic Chemistry

(Total Credits: 2; Contact hrs: 30) **Marks: 50 (40+10)**

Learning Objectives:

- To study nature of bonding in organic molecules.
- To inculcate the detailed basics of reaction mechanism and various intermediates
- To study the different types of electronic effects.
- To understand the stereochemistry of organic compounds.
- To inculcate imagination and critical thinking of 3D structures of organic compounds.
- To study the unsaturated and alicyclic compounds.
- To study the concept of aromaticity, its applications and reactions.

Course Outcome: After the end of the course, student can:

- Understand the basics of bonding and able to draw correct structure of any organic molecule and comment on its stability.
- Able to predict the reactivity of organic molecules by the help of electronic effects.
- Understand the different reactions along with formation of intermediates.
- Able to think and predict the possible mechanism of various critical organic reactions.
- Able to imagine 3D structure of organic molecules.
- Easily comment on aromaticity of any organic compound and its stability
- Able to distinguish between saturated, unsaturated, alicyclic, aromatic and heterocyclic compounds.

Unit-I **(Contact hrs: 15)**

1. Fundamentals of organic reaction mechanism (Contact hrs: 05)

1.1 Introduction of reaction mechanism.

1.2 Types of arrow notations: Single headed curved arrow, Half headed curved arrow and double headed arrow.

1.3 Types of bond breaking: Homolytic and Heterolytic

1.4 Types of reagents: Electrophilic and Nucleophilic

1.5 Types and sub-types of following organic reactions with definition and at least one example of each. a)Substitution b) Addition c) Elimination d) Rearrangement. (Mechanism is not expected)

1.6 Reactive Intermediates: Carbocations, Carbanions, Carbon free radicals, Carbenes, Nitrenes (Definition with suitable example, formation, structure, and relative stability)

2. Structure and Bonding **(Contact hrs: 05)**

2.1 Hybridization:sp^3, sp^2 and sp w.r.t. methane, ethylene and acetylene respectively
2.2 Bond length, Bond angle and Bond energy with factors affecting these properties w.r.t. sp^3, sp^2 and sp hybridization.
2.3 Resonance effect w.r.t. phenol and nitrobenzene
2.4 Inductive effect, + I and –I
2.5 Strength of carboxylic acid w.r.t. inductive effect: Examples- a) Formic and acetic acid, b) monochloro, dichloro and trichloroacetic acid
2.6 Hyperconjugation w.r.t. toluene
2.7 Steric effect w.r.t. mesitoic acid

3. Stereochemistry of organic compounds **(Contact hrs: 05)**

3.1 Types of stereo-isomerism: Optical isomerism, Geometrical isomerism and Conformational isomerism
3.2 Optical activity
3.3 Essential conditions for Optical activity
a) Elements of symmetry
b) Chiral center w.r.t. lactic acid
3.4 Optical isomerism in lactic acid and tartaric acid
3.5 Enantiomers and diastereoisomers w.r.t. 2,3-dihydroxybutanoic acid
3.6 Racemic modification.
3.7 Geometrical isomerism: Introduction
3.8 Cause of geometrical isomerism.
3.9 Geometrical isomerism in maleic acid and fumaric acid.

Unit-II **(Contact hrs: 15)**

1. Cycloalkanes **(Contact hrs: 03)**

1.1 Cycloalkanes: Nomenclature, Methods of formation:
a) Internal Wurtz reaction
b) Distillation of calcium or barium salt of dicarboxylic acid
1.2 Chemical properties of cyclopropane
a) Free radical substitution of chlorine in presence of light.
b) Action of HBr and conc. H_2SO_4
c) Catalytic reduction by H_2/Ni
1.3 Industrial applications of cycloalkanes.

2. Alkenes, Dienes and Alkynes **(Contact hrs: 06)**

2.1 Nomenclature of alkenes.
2.2 Methods of formation of alkenes with mechanism
a) By dehydration of lower alcohols.

b) By dehydrohalogenation of lower alkyl halides.

2.3 Chemical reactions of alkenes: Hydrogenation, Electrophilic and free radical additions, Hydroboration, Oxidation, Epoxidation, Ozonolysis, Hydration, Hydroxylation, Oxidation with $KMnO_4$, Polymerization of alkenes: ethylene and propylene

2.4 Nomenclature and classification of dienes.

2.5 Isolated, Conjugated and cumulated dienes.

2.6 Butadiene: Methods of formation, polymerisation, 1, 2- and 1,4- additions and Diel's-Alder reaction.

2.7 Alkynes: Nomenclature, Acidity of alkynes.

2.1 Electrophilic and Nucleophilic addition reactions, Hydroboration, Oxidation.

2.9 Industrial applications of ethylene, 1,3-butadiene and acetylene.

3. Aromaticity and Benzene (Contact hrs: 06)

3.1 Aromatic, non-aromatic, antiaromatic and pseudo aromatic compounds.

3.2 Kekule structure of benzene

3.3 Resonance structures of benzene.

3.4 Molecular orbital picture of benzene.

3.5 Representation of benzene ring.

3.6 Modern theory of aromaticity. Fundamental Concepts: Delocalisation of electrons, coplanarity and Huckel's $(4n+2)\ \pi$ rule. Applications of Huckel's rule to napthalene, pyrrole and pyridine.

37 Mechanism of electrophilic aromatic substitution in benzene w.r.t. nitration, sulphonation, halogenations and Friedel-Craft's reaction: alkylation and acylation.

Reference Books

1) Organic Chemistry: Hendrickson, Cram, Hammond.

2) Organic Chemistry: Morrison and Boyd

3) Organic Chemistry: Volume I and III. L. Finar

4) Organic Chemistry: Pine

5) Advanced Organic Chemistry: Sachinkumar Ghosh

6) Advanced Organic Chemistry: B. S. Bahl and Arun Bahl

7) A Guide book to Mechanism in Organic Chemistry: Peter Sykes

8) Stereochemistry of Organic Chemistry: Kalsi,

9) Stereochemistry of Carbon Compounds: Eliel

10) Textbook of Organic Chemistry: P. L. Sony

11) Practical Organic Chemistry: A. I. Vogel

12) Advanced Organic Chemistry: Reactions, Mechanism and Structure: Jerry March

13) Organic Chemistry: M. R. Jain

14) Organic Chemistry: J. M. Shaigel

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SEMESTER-II
PAPER IV: Analytical Chemistry

(Total Credits: 2; Contact hrs: 30) **Marks: 50 (40+10)**

Learning Objectives:

1. To study the different types elements present in the organic compounds
2 To understand the qualitative analysis methods of C, H, N, S and halogen
3. To study the basic principle and classification of chromatography.
4. To study the paper chromatography and its applications.

Course Outcomes: After the end of the course, student can:

1. Understand the basic elements present in the organic compounds
2. Able to understand the qualitative analysis methods of C, H, N, S and halogen
3. Easily understand the basic principle and classification of chromatography
4. Able to know paper chromatography and its applications.

Unit-I **(Contact hrs: 15)**

1. Fundamentals of Analytical Chemistry (Contact hrs: 05)

1.1 Basic principle of titrimetric analysis and classification
1.2 Preparation and dilution of reagents/solutions.
1.3 Normality, Molarity and Mole fraction, Weight by weight (w/w), Weight by volume (w/v). Use of $N_1V_1 = N_2V_2$ formula
1.4 Preparation of ppm level solutions from source materials (salts), conversion factors, density and specific gravity of solutions, problems are expected.

2. Physical properties of liquids (Contact hrs: 10)

2.1 Introduction, additive and constitutive properties
2.2 Viscosity, coefficient of viscosity, determination of viscosity by Ostwald's Viscometer
2.3 Surface tension:- Determination of surface tension by Drop –Weight method
2.4 Parachor: Macleod equation and its modification by Sugden, applications of parachor in the determination of molecular structures as benzene and NO_2 group
2.5 Dipole moment, electrical polarization of molecules
2.6 Use of dipole moment in the study of molecular structure
2.7 Refractive index, Snell's law
2.8 Specific and molecular refractivity, Abbe's refractometer: Critical angle Principle, construction, working and advantages
2.9 Molecular refractivity and chemical constitution

Unit-II **(Contact hrs: 15)**

1. Qualitative and Quantitative Analysis (Contact hrs: 06)

1.1 Qualitative analysis of Carbon, Hydrogen, Nitrogen & Sulphur

1.2 Quantitative analysis of-

a) Carbon and hydrogen by Combustion method

b) Nitrogen by Kjeldahl's method

c) Halogen and Sulphur by Carius method.

1.3 Determination of molecular weight of an acid by titration method.

1.4 Empirical formula and molecular formula determination.

1.5 Numerical Problems

2. Chromatography (Contact hrs: 04)

2.1 Introduction and General principle of Chromatography

2.2 Classification of Chromatography based on nature of stationary and mobile phase.

2.3 Paper Chromatography: Principle, Experimental procedure and applications

3. Analysis of food products (Contact hrs: 05)

3.1 Nutritional value of foods, idea about food processing and food preservation and adulteration.

3.2 Identification of adulterants in some common food items like milk, coffee powder, chilli powder, turmeric powder, coriander powder, pulses.

REFERENCE BOOKS

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
4. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).
5. Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis,
6. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
7. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
8. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India
12. G D Christian -Analytical Chemistry
13. Qualitative Organic Analysis 4th Edn by A I Vogel (ELBS)
14. Vogel's Quantitative Analysis
15. Douglas A Skoog, Donald M West, F James Holler ,Stainly R Crounch , Fundamentals of Analytical Chemistry, 9th edition
16. David Harvey, Modern Analytical Chemistry, McGraw Hill Higher education
17. Gurudeep R Chatwal, Sham K Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
18. Barrow, G.M. Physical Chemistry Tata McGraw Hill (2007).

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SEMESTER-I & II
Chemistry Practical - I

(Total Credits: 4, Contact hrs: 4 hrs per week) **Marks: 100 (80+20)**

N.B. i) Use of Digital balance is allowed.
ii) Use S.I. Units Wherever Necessary.
iii) Any 20 practicals out of total are mandatory.

A) Physical Chemistry

1) Determination of equivalent weight of Mg by Eudiometer.
2) Study of specific reaction rate of hydrolysis of methyl acetate in presence of HCl.
3) Study of specific reaction rate of hydrolysis of methyl acetate in presence of H_2SO_4
4) Study of reaction between $K_2S_2O_8$ and KI (Equal Concentrations)
5) Determination of heat of ionization of weak acid.

B) Inorganic Chemistry

1) Inorganic Quantitative Analysis: Volumetric Analysis

i) To prepare a standard solution of Oxalic acid and determine the strength of Sodiumhydroxide solution in terms of normality and Kg/dm^3

ii) To prepare a standard solution of Oxalic acid and determine the strength of Potassiumpermanganate solution in terms of normality and Kg/dm^3

iii) To prepare standard solution of Potassium dichromate and determine strength of FerrousAmmonium Sulphate solution in terms of normality and Kg/dm^3 (Use internal indicator)

2) Inorganic preparation:

i) Preparation of ferrous ammonium sulphate
ii) Preparation of sodium cuprous thiosulphate

C) Organic Chemistry

1) Organic Qualitative Analysis.

Identification of at least **six** organic compounds with reactions including at least one from acids, phenols, bases and neutrals from the list of the compounds given below-

i) Acids : Oxalic acid, Benzoic acid and Cinnamic acid
ii) Phenols : β - Naphthol, Resorcinol.
iii) Bases : Aniline, p - Toluidine.
iv) Neutrals : Acetone, Ethyl acetate, Glucose, Chloroform, Chlorobenzene,m-dinitrobenzene, Thiourea.

Note : A systematic study of an organic compound involves the following operations which should be taught in details with reactions in the detection of elements and functional group.

1) Preliminary tests and physical examination
2) Determination of physical constant
3) Detection of Elements
4) Determination of functional group
5) Comparison with literature
6) Confirmatory Test
7) Summary
8) Result

2) Organic Preparation:

i) Preparation of benzoic acid from benzamide.

ii) Preparation of dibenzal acetone from benzaldehyde and acetone.
(Wt. of crude product is expected. M.P. of the recrystallized product is not expected.)

D) Analytical Chemistry

1) Determination of viscosity of given liquids A and B. (Density data of liquids, viscosity of water to be given.) [Any two liquids from, Acetone, CCl_4, Ethyl alcohol, Ethylene glycol and n- propyl alcohol]
2) Determination of refractive index and specific refraction of given liquids. [Any two liquids from, CCl_4, $CHCl_3$, benzene, xylene, toluene, ethyl alcohol]

3) Estimations : (any two)

i) Estimation of aniline
ii)Estimation of acetamide
iii) Estimation of Aspirin

4) Qualitative Analysis:

i) Spot Tests: Detection of following cations using spot tests : Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{3+}, Zn^{2+},Mg^{2+}, Al^{3+}, Pb^{2+}.

ii) Chromatography: Separation and identification of cations by Paper Chromatographic technique from the following mixtures :

a) Ni^{2+} + Cu^{2+}
b) Ni^{2+} + Co^{2+}
c) Cu^{2+} + Co^{2+}

Reference Books:

1) Practical book of Physical Chemistry : Nadkarni, Kothari & Lawande.
2) Experimental Physical Chemistry : A. Findlay.
3) Systematic Experimental Physical Chemistry : S.W. Rajbhoj, Chondhekar (Anjali Pub.)
4) Experiments in Physical Chemistry : R.C.Das and B. Behra. (Tata Mc. Graw Hill)
5) Advanced Practical Physical Chemistry : J. B. Yadav (Goel Publishing House)
6) Practical Physical Chemistry : B. D. Khosala (R. Chand & Sons.)
7) Experiments in Chemistry : D. V. Jahagirdar
8) Vogel's Text Book of Quantitative Chemical Analysis (Longman ELBS Edition)

9)Vogel's Text Book of Qualitative Chemical Analysis (Longman ELBS Edition)
10)Basic Concepts in Analytical Chemistry (Wiley Eastern Ltd.) : S. M. Khopkar
11)Hand book of Organic Qualitative Analysis : Clarke
12) Comprehensive Practical Organic Chemistry - Quantitative Analysis by V.K. Ahluwalia,Sunita Dhingra, University Press. Distributor - Orient Longman Ltd.,
13) Comprehensive Practical Organic Chemistry preperation and Quantitative Analysis. : V.K. Ahluwalia, Renu Agarwal, University Press. Distributor - Orient Longman Ltd.,
14)A laboratory Hand-Book of organic Qualitative Analysis and separation :V. S. Kulkarni,Dastane Ramchandra and Co. Pune.

Note:

1. Minimum 20-22 experiments from four sections should be completed during academic year.

2. Experiments from all the four sections should be covered.

- **University Examination:** University examination will be conducted by as per the guidelines issued by the PAH Solpaur University, Solapur.

1. **Theory Paper I : 40 Marks**
2. **Theory Paper II : 40 Marks**
3. **Theory Paper III : 40 Marks**
4. **Theory Paper IV : 40 Marks**
5. **Practical : 80 Marks**
6.

Practical paper has 80 marks for university practical examination. Duration ofpractical examination is one day. There will be TWO practicals, (P+I/I+O/O+A/A+P). Out of 80 marks for university practical examination, the mark distribution is as follows.

Q. 1 Any Two: (30+30)=60 Marks

A) Physical Chemistry experiment :
B) Inorganic Chemistry experiment :
C) Organic Chemistry experiment :
D) Analytical Chemistry Experiments :

Q. 2 Oral : 10 marks
Q. 3 Journal : 10 marks

Total Marks : 80 marks