Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara
(Autonomous)
Department of Chemistry
Syllabus for Bachelor of Science Part – I (B. Sc. -I)

1. Title: B. Sc. Chemistry

2. Year of Implementation: 2021-2022

3. Preamble: This updated syllabus is prepared for first year undergraduate students. At this level, to develop their interest towards chemistry as basic science and also to prepare them for the academic and industrial exposure simultaneously. Introduction of instrumental techniques with the regular chemistry exercises will help to enhance analytical thinking of the students.The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at first year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.

4. General Objectives of the Course:

1. To develop the content of the syllabus according to the UGC norms.
2. To inculcate fundamental principles of chemical sciences in students.
3. To establish the link between theory and laboratory practice by conducting laboratory. experiments which help students to improve the understanding of the concepts.
4. To enhance student's sense of enthusiasm for chemistry and to involve them in an intellectually stimulating experience of learning in a supportive environment.

5. Duration: One year

6. Pattern: Semester

7. Medium of Instruction: English

8. Structure of Course:

Theory Course		Practical Course (Semester Wise)
Semester I	**Semester II**	
Course I-Physical Chemistry Course Code: BCT-101	Course I-Organic Chemistry Course Code: BCT-201	Course Code: BCP 103:Lab I
Course II-Inorganic Chemistry Course Code: BCT-102	Course II-Analytical Chemistry Course Code: BCT-202	Course Code: BCP 203:Lab II

Structure and Titles of B. Sc. Course
B. Sc. I Semester I
Course I : Physical Chemistry (BCT 101)

Marks: 30

Subject	Unit No.	Title	Periods	Credits
Physical Chemistry	I	Chemical Thermodynamics	**09**	**2**
	II	Chemical Equilibria	**08**	
	III	Chemical Kinetics	**10**	
	IV	Kinetic Theory of Gases	**09**	
Grand Total			**36**	

Course II: Inorganic Chemistry (BCT 102)

Marks: 30

Subject	Unit No.	Title	Periods	Credits
Inorganic Chemistry	I	Quantum Chemistry and Atomic Structure	**12**	**2**
	II	Ionic Bonding	**07**	
	III	Covalent Bonding	**07**	
	IV	Molecular Orbital Theory (MOT)	**10**	
Grand Total			**36**	

Semester II
Course III: Organic Chemistry (BCT-201)

Marks: 30

Subject	Unit No.	Title	Periods	Credits
Organic Chemistry	I	Fundamentals of Organic Chemistry	**12**	**2**
	II	Stereochemistry	**10**	
	III	Chemistry of Aliphatic Hydrocarbon	**07**	
	IV	Chemistry of Aromatic Hydrocarbons	**07**	
Grand Total			**36**	

Course IV: Analytical Chemistry (BCT 202)

Marks: 30

Subject	Unit No.	Title	Periods	Credits
Analytical Chemistry	I	Basic concepts in Analytical Chemistry	**18**	**2**
	II	Purification and separation methods	**06**	
	III	Introduction to Chromatography	**06**	
	IV	Water Analysis	**06**	
Grand Total			**36**	

Other Features:

A) Library: Reference and Textbooks, Journals and Periodicals, Reference Books for Advanced Books for chemistry Advanced studies. –List Attached

B) Specific Equipments: Necessary to run the Course, Computer, LCD, Projector, Visualizer, Smartboard

C) Laboratory Equipments: Apparatus & equipments and chemicals required.

Apparatus	**Apparatus**
Eudiometer Tube	Tripod Stand
Digital balance	Burette Stand
$1/10^0$C thermometer	Test Tube Holder
Polythene bottles	Test Tube Stand
Measuring Cylinder	Spot Tile
Stopper Bottle	Droper
Test Tube	Dryer
Thile's Tube	Watch glass
Capillary Tube	Viscometer
Evaporating Dish	Stop Watch
Glass Rod	Burette
Wire Gauze	Pipette
Burner	Conical Flask
Water Bath	Volumetric Flask
Chromatographic Paper	Iron Stand
Glass Jar	Beaker

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Syllabus Introduced from June 2020-21

B. Sc. Part I, Semester I

Theory: Course I: Physical Chemistry

Course Code: BCT 101

Marks: 30 **Credits: 2**

Learning Objectives:

1. To strengthen the physical basis of thermochemical changes through thermodynamic study.
2. To make students familiar about chemical processes, reactions, energy changes during the reaction.
3. To train students to calculate different parameters in chemical change.
4. To gain the conceptual understanding regarding behaviour of gases.

Unit I: Chemical Thermodynamics [09 L]

Introduction, Spontaneous and non-spontaneous process with examples, Statement of Second law of Thermodynamics, Carnot's cycle, its efficiency, Carnot's Theorem (Heat engine), Concept of entropy, physical significance of entropy. Entropy as a function of volume and temperature, pressure and temperature, entropy of mixing of gases, entropy change accompanying phase transition. Third law of thermodynamics and determination of absolute entropy. Numerical problems.

Ref. 1 *Page No. 517-521* ***Ref. 2*** *Page No. 1.547-1.556,* ***Ref.2*** *Page No. 1.568-1.577*

Unit II: Chemical Equilibria [08 L]

Concept of free energy, Free energy change in chemical reaction, Thermodynamic derivation of law of chemical equilibrium. Distinction between ΔG and ΔG^0, Le Chatelier's principle, conditions for maximum yield in industrial processes like manufacture of ammonia and sulphuric acid. Relationship between K_p, K_c and K_x for reactions involving ideal gases.

Ref. 3 *page no. 621-672*

Unit III: Chemical Kinetics [10 L]

Introduction, Rate of reaction, Definition and units of rate constant, Factors affecting rate of reaction. (nature of reactant, concentration, pressure, temperature and catalyst.) Order and Molecularity of reaction, Zero order reaction, first order reaction, Characteristics of first order reaction. Examples, Pseudo-unimolecular reactions, examples. Second order reaction: Derivation of rate constant for equal and unequal concentration of the reactants. Characteristics of Second order reaction. Determination of order of reaction by i) integration method ii) graphical method iii) Half-life method, Effect of temperature on rate of reaction, Arrhenius equation, Concept of energy of activation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Numerical problem

Ref. 3 *Page No.731-770.*

Unit- IV: Kinetic Theory of Gases [09 L]

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Ideal and Non ideal gases, Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. Van der Waals equation of state for real gases. Explanation of real gas behaviour by Van der Waal's equation, Boyle temperature (derivation not required).Critical Phenomena: PV-isotherms of real gases (Andrew's isotherms), Continuity of state, Critical constants and their calculation from vander Waals equation. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Numerical Problems.

Ref. 3 *Page No.355-414.*

Learning Outcomes: By studying above syllabus students will able to explore and study

Unit I: Chemical Thermodynamics

1. Laws of thermodynamics.
2. The concept of entropy.
3. Numerical problems based on theory.

Unit II: Chemical Equilibria

1. The free energy concept and chemical equilibrium.
2. Le Chatelier's principle and its application to industrial processes.

Unit III: Chemical Kinetics

1. Zero, first, second order and pseudo unimolecular reactions.
2. Methods of determining order of reaction.
3. Theories of reaction rates.
4. Numerical problems based on theory.

Unit IV: Kinetic Theory of Gases

1. The kinetic theory of gases.
2. The concept of critical phenomena, critical constants and their calculation from Van der Waal's equation.
3. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies and their importance.

Theory References:

1. B. R. Puri, L. R. Sharma, Madan S. Pathania, Principles of Physical Chemistry- (Vishal Publishing Co., 2013).
2. P. L. Soni, O. P. Dharmarha, U. N. Dash, Text Book of Physical Chemistry (Sultan Chand and Sons, 2016).
3. Arun Bahl, B. S. Bahl, G. D.Tuli, Essentials of Physical Chemistry, (S. Chand and Company Ltd., 2020).
4. C. N. R. Rao, University General Chemistry -An Introduction to Chemical Science (New Delhi, Macmillan, 2009).
5. Peter Atkins, Julio de Paula, James Keeler, Atkins Physical Chemistry, (Oxford Uiversity Press, 2017).

Theory: Course II: Inorganic Chemistry
Course Code: BCT 102

Marks: 30 **Credits: 2**

Learning Objectives:

1. To make students familiar with structure and bonding in ions/molecules.
2. To enable them to calculate the parameters affecting crystal structure of molecules.
3. To enable students to correlate the physical and chemical properties of elements and their compounds with their position in periodic table.

Unit I: Introduction to Quantum Chemistry & Atomic Structure [12 L]

Black Body radiation, Photoelectric effect, Compton Effect, Plank's theory, De-Broglie's relationship, Bohr's theory of hydrogen atom, Hydrogen spectrum, Wave theory, Heisenberg's uncertainty principal, Atomic orbitals & Quantum numbers, Pauli's exclusion principle, Hund's multiplicity rule, Aufbau principle, Electronic configuration of elements.

***Ref.1**: Page 1-16, Page 35-40, Page 45,Page 50-52;**Ref.2**: Page 34;*
***Ref.3**: Page 1-7, Page 31,Page 66-86; **Ref.4**: Page 3-39.*

Unit II: Ionic Bonding [07 L]

Definition, General Characteristics of ionic bonding, Formation of ionic bonds, Energetics of ionic bond formation statement of Born-Lande equation for calculation of lattice energy, Born– Haber cycle & it's applications, Fajan's rules, Radius ratio, Radius ratio effects & calculation of radius ratio for octahedral geometry, Structure of NaCl, Rutile (TiO_2).

***Ref.1**:Page 137-140; **Ref.3**: Page 175-194; **Ref.6**:Page 422-437; **Ref.7:** Page 43-58*

Unit III: Covalent Bonding [07 L]

VBT approach, Valence shell electron pair repulsion theory (VSEPR), VSEPR approach, assumptions, examples and limitations

***Ref.1**:Page 141-149, **Ref.3**: Page 200-223; **Ref.6**:Page 437-479; **Ref.7**: Page 33-41.*

Unit IV: Molecular Orbital Theory (MOT) [10 L]

Introduction to LCAO method, Formation of bonding, anti-bonding & non-bonding molecular orbitals, Conditions for successful overlaps, Types of overlaps, Energy level sequence for molecular orbitals when n = 1 & n = 2, Bond order & it's significance, Molecular orbital diagrams for–

a. Homo nuclear diatomic molecules – He_2, B_2, N_2, O_2, O_2^+
b. Hetero nuclear diatomic molecules – CO, NO, NO^+
c. Comparison between VBT &MOT

***Ref.1**:Page 160-179; **Ref.2:** Page 134-138; **Ref.4**:Page 368-433; **Ref.5**: Page 129-140, Page 146-148; **Ref.4**:Page 576-591; **Ref.7**: Page 89-112.*

Learning Outcomes: By studying above syllabus students will able to understand

Unit I: Introduction to Quantum Chemistry & Atomic Structure

1. Difference between classical chemistry and modern chemistry.
2. The concept of atom and molecule.
3. The formation of atomic orbital through quantum approach.
4. The behavior of electron in atom.

Unit II: Ionic Bonding

1. The formation of various types of bonds.
2. The structure of solids and various types of bonds present in crystal structure.
3. The geometry and structure of ionic solids.
4. The Born-Lande equation, Born–Haber cycle, Fajan's rule and various aspects of lattice points in ionic solids.

Unit III: Covalent Bonding

1. The concept of covalent bond.
2. The VBT approach.
3. The VSEPR theory and comparison between linear and nonlinear molecule.

Unit IV: Molecular orbital theory (MOT)

1. The formation of molecule from atomic orbitals.
2. The concept of LCAO method, bonding, anti-bonding and non-bonding molecular orbitals.
3. The concept of overlapping of atomic orbitals.
4. The application of VBT and MOT to homo-nuclear and hetero-nuclear diatomic molecules.

Theory References:

1. Puri, Sharma & Kalia, Principles of Inorganic Chemistry (Vishal Publishing Co., 2020).
2. Gary Miessler, Donald Tarr, Inorganic Chemistry (Pearson Education, 2008).
3. Manas Chanda, Atomic Structure and Chemical Bonding (IK International Publishing House Pvt. Ltd., 2019).
4. R. K. Prasad, Quantum Chemistry (New Age Science, 2009).
5. James Huheey, Allen Keiter, Richard Keiter, Okhil Medhi, Inorganic Chemistry, Principles of Structure and Reactivity (Pearson Education, 2014).
6. R. D. Madan, Modern Inorganic Chemistry (S. Chand Ltd, 1987)
7. J. D Lee, Concise Inorganic Chemistry (Wiley-Oxford University Press, 2008).

Practical Course: BCP- 103: Lab I

Learning Objectives:

1. To impart practical skills and learn basics behind experiments.
2. To prepare background for advanced and applied studies in Chemistry.

List of Experiments:

Section A: Physical Chemistry (Minimum four experiments)

1. Determination of Enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
2. Determination of heat of ionization of weak acid by using polythene bottle.
3. Preparation of Buffer solutions.
   I) Sodium Acetate –Acetic Acid and Ammonium chloride – Ammonium hydroxide
   II) Measurement of pH of buffer solution & comparison of values with theoretical values
4. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos & soaps using pH meter.
5. Chemical Kinetics: To study the hydrolysis of methyl acetate.
6. Chemical Kinetics: To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentration of reactants. (Plotting of graph).
7. Equivalent weight: To determine equivalent weight of metal (Mg) by hydrogen displacement method using Eudiometer.

Section B: Inorganic Chemistry (Minimum four experiments)

8. Quantitative Analysis:
   Gravimetric Analysis (volatilization gravimetric analysis)
   Binary Mixture 1) $NH_4Cl + BaSO_4$
   2) $ZnO + ZnCO_3$
9. Volumetric analysis:
   I. Preparation of standard 0.1 N $KMnO_4$ solution and determine the strength of given oxalic acid solution.
   II. Determine quantity of Fe (II) ions from the given solutions by titrating with 0.1 N $K_2Cr_2O_7$ solutions by using internal indicator.
   III. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method.
10. Any other relevant practical may be added.

Practical Course Learning Outcomes:

Students will be able to explore theoretical knowledge in understanding and analysis

1, 2. Determination of Enthalpy of neutralization of hydrochloric acid with sodium Hydroxide and Determination of heat of ionization of weak acid

1. The enthalpy of neutralization and ionization
2. Acurate temperature measurements of solutions and mixtures.

3. Preparation and measurement of pH of Buffer solutions.

1. The buffer solution, types of buffer solution.
2. The preparation of different buffer solutions.
3. Calculation of pH of buffer solutions and their comparision with theoretical values.

4. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos & soaps using pH meter.

1. The standardization and operation of pH meter.
2. The application of pH metry in measurement of various commercial samples including fruit juices, shampoos.

5, 6 Chemical Kinetics: To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentration of reactants (Plotting of graph).

1. The concepts of rate, order of reactions, rate constants and their units.
2. The reaction between $K_2S_2O_8$ and KI and its mechanism with equation for rate constant.
3. The rate constant calculation from from experimental data as well as by graphical method.

7. Equivalent Weight: To determine equivalent weight of metal (Mg) by hydrogen displacement method using Eudiometer.

1. The concept of equivalent weight, atomic weight.
2. The measurement of volume of gas and height of solution by using eudiometer.
3. Calculation of equivalent weight from experimental data.

8. Quantitative Analysis:

1. The concept of quantitative analysis, its types.
2. Weighing techniques.
3. Calculation of exact strength of given composition.

9. Volumetric Analysis:

1. The concept of primary and secondary standard, volumetric analysis.
2. Preparation of standard solutions
3. Determination of strength of solutions.

Practical References:

1. P. S. Sindhu, Practical in Physical Chemistry A Modern Approach, (Macmillan Publication, 2006).
2. B. Khosala, V. Garg, Adarsh Gulati, Senior Practical Physical Chemistry, (Delhi, R. Chand and Co, 2018).
3. V. D. Athawale, Parul Mathur, Experimental Physical Chemistry, (New Age International Private Ltd., 2001).
4. Alexander Findlay, B P Levitt, Findlay's Practical Physical Chemistry, (London, Longman, 1973).
5. Vogel's Text Book of Qualitative Chemical Analysis (Longman, 1989).
6. Arthur Vogel, Vogel's Text Book of Quantitative Analysis (Longman, 1989).
7. Alexander Findlay, Experimental Physical Chemistry-Scholar's Choice Edition (Creative Media Partners, LLC, 2015).
8. Arthur Vogel, John bassett, A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, (Longman Sc and Tech, 1980).

Semester –II
Theory: Course III: Organic Chemistry
Course Code: BCT 201

Marks: 30 **Credits: 2**

Learning Objectives:

1. To understand the basic concepts of organic chemistry.
2. To understand the structure and reactivity concept of organic compounds.
3. To learn the basics of stereochemistry of organic molecules.
4. To explore chemistry of aliphatic and aromatic compounds.

Unit I: Fundamentals of Organic Chemistry [12 L]

Introduction: inductive, electromeric, resonance and hyperconjugation effect. Cleavage of bonds. Types of reagents and organic reactions. Introduction of Reactive intermediaries, carbocation, carbanion, carbon free radical, carbene, nitrene, arynes.

Ref.1: *Pages 55 – 59, 64 – 87* ***Ref.2:*** *Pages 20 – 22, 53-76, 101 -119, 122, 174 -176,251, 270-298.* ***Ref.3:*** *Pages 75 – 163;* ***Ref.6:*** *Pages 110 – 125;* ***Ref.7:*** *Pages 78 –120.*

Unit II: Stereochemistry [10 L]

Concept of stereochemistry, types of stereoisomerism, chiral and achiral compounds, optical isomerism in tartaric acid, 2,3-dihydoxy butanoic acid, enantiomerism and diastereomerism. Gometrical isomerism: Introduction, geometrical isomerism in aldoxime & ketomixes, configuration of aldoximes & ketoximes, nomenclature of stereoisomerisms DL,CIP rules: R/S, E and Z (cis trans), erythro and threo.

Ref.1: *Pages 43 – 52, 194 – 200;* ***Ref. 4:*** *Pages 4 -11, 16-58, 318 - 321*
Ref. 5: *Pages 1 – 187;* ***Ref. 6:*** *Pages 67 – 104.*

Unit III: Chemistry of Aliphatic Hydrocarbons [07 L]

Introduction, Alkanes: preparation methods and chemical reactions, Alkenes: Preparation methods and chemical reactions, Alkynes: Preparation methods and chemical reactions Cycloalkanes: Preparation methods and reactions.

Ref.1: *Pages 134– 150, 234 -253, 302, 415, 416;* ***Ref. 3:*** *Pages 260 – 309, 343 – 515;*
Ref. 6: *Pages 328 -374.*

Unit IV: Chemistry of Aromatic Hydrocarbons [07 L]

Introduction to homocyclic and polycyclic aromatic hydrocarbons: benzene, naphthalene, anthracene. Meaning of important terms; aromatic, non aromatic, anti aromatic compounds. Huckel's rules and its applications. Aromatic electrophilic substitution reactions, effect of substitution groups. General mechanism of electrophilic substitution reactions, Aromatic nucleophilic substitution (addition –elimination); orientation, activating & deactivating groups

Ref.1: *Pages, 262 -283, 426 -474, 479–497;* ***Ref. 2:*** *Pages 131 - 173;* ***Ref. 3:*** *Pages 517 -548;* ***Ref. 7:*** *10 -26.*

Learning Outcomes: By studying above syllabus students will be able to learn

Unit I: Fundamentals of Organic Chemistry

1. The basic concepts of organic chemistry.
2. Different reactive intermediates, types of reagents and reactions.
3. The preparations and reactions of reactive intermediates.

Unit II: Stereochemistry

1. Basic concepts of stereochemistry.
2. Types of stereoisomerism, enantiomerism, diasteromerism
3. The concept of chirality, geometrical isomerism in aldoxime and ketoxime.

Unit III: Chemistry of Aliphatic Hydrocarbons

1. Basic idea of aliphatic hydrocarbons.
2. The preparations and reactions of aliphatic hydrocarbons.
3. Cyclo derivatives of hydrocarbons with respect to preparation methods and reactions.

Unit IV: Chemistry of Aromatic Hydrocarbons

1. The concept of aromatic hydrocarbons.
2. Types of reactions including electrophilic and nucleophilic substitution reactions.

Theory References:

1. Robert Morrison, Robert Boyd, Organic Chemistry (Prentice Hall, 1998).
2. Peter Sykes, A Guidebook to Mechanism in Organic Chemistry (Pearson Education, 2003).
3. S. M. Mukharji, S. P. Singh, R. P. Kapoor, R. Dass, Organic Chemistry-As per UGC Syllabus, (New Age International Publishers, 2017).
4. Ernest Eliel, Samual Welen, Stereochemistry of Carbon compounds, (Wiley India Ed^{n}, 1994).
5. P. S. Kalsi, Stereochemistry: Conformation & Mechanism, (New Age International Publishers, 2017).
6. Raj Bansal, A Text books of Organic Chemistry (New Age International Publishers, 2016).
7. V. K. Ahluwalia, Rakesh Parashar, Organic Reaction Mechanism, (Narosa Publishing House, 2010).

Theory: Course IV: Analytical Chemistry
Course Code: BCT 202

Marks: 30 **Credits: 2**

Learning Objectives:

1. To develop analytical skills among the students.
2. To acquire expertise in chemistry laboratory in handling of reagents and solvents.
3. To familiarize basic unit processes.
4. To acquire the knowledge of separation and purification techniques.

Unit I: Basic Concepts in Analytical Chemistry [09 L]

A) Concentration Units: Introduction, Definition and Explanation of following terms- Solute, Solvent, Solution, Polar solvent, Non-Polar solvent, Saturated solution, Unsaturated solution, Super saturated solution, Normality, Equivalent weight, Molecular weight, Molarity, Acidity of base, Basicity of acid, Percentage solution, ppt, ppm, ppb solutions, Mole Fraction, Weight fraction, Percentage composition by W/W, W/V, V/V Problems based on Normality, Molarity, mole fraction, mixed solution, etc. Errors, Precession.
Ref.1: *Pages 20 -44; 144– 172;* ***Ref. 2:*** *Pages 151-268.*

B) Ionic Equilibria: Strong and weak electrolytes, Degree of Ionization, Factors affecting degree of ionization, Ionization constant and ionic product of water. Ionization of weak acids&bases,Common Ion effect, pH scale, Buffers, types of buffer. Solubility & solubility product of sparingly soluble salt, Numerical problems.
Ref. 3: *Page No.370-377;* ***Ref. 4:*** *Page No. 2.484-2.49, 2.434-2.407.*

Unit II: Purification and Separation Method [06 L]

Distillation techniques, Distillation of liquid mixtures, Types of distillation,Types of columns and packing, Condensers, Vacuum distillation, Spinning-band distillation, Steam distillation, Keigelrohr distillation, Isopiestic or isothermal distillation, Recrystallization Techniques, Filtration, Choice of solvents, Petroleum ethers, Mixed solvents Sublimation.
Ref. 5: *Pages 141 – 163;165-218.*

Unit III: Introduction to Chromatography [06 L]

Introduction, Basic Principle of Chromatography, Basic terms, Classification of Chromatography, Paper Chromatography- Principle, Methodology-types of papers and treatment, sample loading, choice of solvent, development-ascending, descending, circular, location of spots, determination of R_f value, Applications, advantages and disadvantages. Thin layer chromatography; Principle, Solvent system, stationary phases, preparation of TLC plate, Detecting reagents, methodology-sample loading, development, detection of spot, R_f value, Applications, advantages and disadvantages, Comparison of paper chromatography and TLC.
Ref. 6: *page no. 585-596.*

Unit IV: Water Analysis [06 L]

Introduction, hardness (Temporary and permanent) Sterilization and disinfection of water; Chemical methods (Aeration, use of $KMnO_4$, ionization, bleaching powder) and physical methods of sterilization (Boiling, exposure to sunlight and UV light, Irradiation with ultrasound) Measurement of water quality by chemical and physical examination: Colour Taste, Turbidity, Alkalinity, Suspended solids, Hydrogen ion concentration, Acidity, Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (OD).
Ref. 7: *Pages 01-24,* ***Ref. 8:*** *Pages 218 – 257.*

Learning Outcomes: After learning above syllabus students will be able to inculcate the acquired knowledge in applying and understanding

Unit I: Basic Concepts in Analytical Chemistry

1. The basic concepts required in laboratory practices.
2. The preparation of solutions of different strengths.
3. The concepts of electrolytes, solubility, mole fraction, buffers, pH, weak and strong acid.

Unit II: Purification and Separation Methods

1. The various purification techniques and separation techniques of solids and liquids.
2. Types of distillation.

Unit III: Introduction to Chromatography

1. The chromatography, mobile phase, stationary phase, Rf value.
2. The preparation of chromatographic strip with spotting of given sample solution.
3. Calculation of Rf value and identification of cations.

Unit IV: Water analysis

1. The concept of water, sources, its types.
2. The quality parameters of water.
3. Various analytical techniques including physical and chemical methods of purification.

Theory References:

1) Gary Christian, Purnendu Dasgupta, Kevin Schug, Analytical Chemistry, (Wiley, 2013).
2) Donald Dahm, Eric Nelson, Calculation in Chemistry, (W. W. Norton & Company, 2012).
3) C. N. R. Rao, University General Chemistry -An Introduction to Chemical Science (Laxmi Publications, 2015)
4) P. Soni, O. Dharmarha, U. Dash, Text book of Physical Chemistry, (Sultan Chand and Son, 2011).
5) J. Bassett, R. C. Denney, G. H. Jeffary J. Medha, Vogels Textbook of Quantitative Inorganic Analysis (Longman Higher Education, 1994).
6) Gurdeep Chatwal, Shyam Anand, Instrumentation Methods of Chemical Analysis, (Himalaya Publishing House, 2016).
7) B. K. Sharma, Industrial Chemistry, (Goel Publishing Housing, 2000).
8) James Girard, Jones Bartlett, Principles of Environmental Chemistry, (Jones and Bartlett Publishers, Inc, 2009).

Practical Course-II : BCP 203: Lab II

Learning Objectives:

1. To impart practical skills and learn principle behind experiments.
2. To prepare background for advanced and applied studies in Chemistry.

List of Experiments:

Section A: Organic Chemistry (Minimum four experiments)

1. Volumetric Analysis: Estimation of Aspirin.
2. Organic Qualitative analysis of organic compounds like Benzoic acid, alpha naphthol, aniline, acetone, ethyl acetate, acetanilde , urea, thiourea etc.
3. Preparations of derivatives of organic compounds
    i) Nitration
    ii) Oximes of aldehydes & ketones
    iii) 2,4-dinitropherylhydrazone of aldehydes & ketones
    iv) Picrate
    v) Oxalate
4. Estimation of Acetamide/Aniline.

Section B: Analytical Chemistry (Minimum four experiments)

5. Separation and identification of cation by paper chromatographic technique from the following mixture i) Ni^{2+} + Cu^{2+}, ii) Ni^{2+} + Co^{2+}, iii) Cu^{2+} +Co
6. Identify & separate mixture of amino acids / sugar by paper chromatography.
7. Purification of compounds by crystallization using suitable solvents.
8. Purification of compounds by sublimation.
9. Purification of compounds by distillation.
10. Any other relevant practical may be added.

Practical Learning Outcomes: Students will have expertise in analytics

1) Estimation of Aspirin

1. The structure of aspirin and its applications.
2. Different sources of aspirin.
3. Standardization and determination of normality.
4. Calculating amount of aspirin in commercial tablets.

2) Organic Qualitative Analysis

1. Qualitative analysis.
2. Methods of determining exact physical constants,.
3. Analysis of elements and functional groups.
4. Type of organic compound.
5. Whole structural analysis and its confirmation using different tests.

3) Preparations of Derivatives of Organic Compounds

1. Meaning of derivative, role of derivative preparation.
2. Different reactions for preparation of derivatives of organic Compounds.
3. Mechanism of reaction.

4) Estimation of Acetamide

1. Recall the concept of volumetric analysis.
2. Difference between back and blank titration.
3. Basic terms of titration, types of indicator.

5) Separation and identification of cation by paper chromatographic technique from the following mixture

i) Ni^{2+} + Cu^{2+}, ii) Ni^{2+} + Co^{2+}, iii) Cu^{2+} +Co^{2}

1. ·The concept of paper chromatography.
2. The separation technique.
3. Making of chromatographic strip with spotting of given sample solution.
4. Calculation of Rf value and identification of components of given mixture.

6) Identify & separate mixture of amino acids/ sugar by paper chromatography

1. Define paper chromatography, Rf value.
2. Knowing different types of amino acids and sugars.
3. Preparation of chromatographic strip with spotting of given sample solution.
4. Calculation of Rf value and identification of components of given mixture.

7) Purification of compounds by crystallization using solvents such as water, alcohol, alcohol-water.

1. The concept of various types of solutions, dilute solutions, saturated solution, concentrated solution.
2. Different crystallization techniques using different solvent systems.
3. Preparation of saturated solution and crystallization sample.
4. Students determine physical constants of purified samples.

8) Purification of compounds by sublimation

1. Sublimation technique.
2. Purification of organic compounds by sublimation method.
3. Determination of physical constants of purified samples.

9) Purification of compounds by Distillation

4. Technique of distillation.
5. Assembly of distillation process.
6. Determination of physical constants of purified samples.

Practical References:

1. Vogel's Text Book of Qualitative Chemical Analysis (Longman ELBS Edition)
2. Arthur Vogel, Text book of Quantitative Chemical Analysis (Longman, 1989)
3. Brian Furniss, Antony Hannaford, Peter Smith, Austin Tatchel, Vogel's Textbook of Practical Organic Chemistry, (Pearson, 2005)
4. O. P. Agrawal, Advanced Practical Organic Chemistry, (Krishna's Educational Publication, 2019)
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Evaluation Pattern

Semester I

Theory Course							Practical Course BCP 103: Lab I			
Course	ESE	Internal Evaluation				Total	ESE	Case Study/ Survey	Student Performance	Total
		ISE-I	ISE-II	Home Assignment I	Home Assignment II					
BCT 101	30	05	05	05	05	100	15	05	05	25
BCT 102	30	05	05	05	05					
Total	60	10	10	10	10					
Grand Total										**125**

Semester II

Theory Course							Practical Course BCP 203: Lab II			
Course	ESE	Internal Evaluation				Total	ESE	Case Study/ Survey	Student Performance	Total
		ISE-I	ISE-II	Home Assignment I	Home Assignment II					
BCT 201	30	05	05	05	05	100	15	05	05	25
BCT 202	30	05	05	05	05					
Total	60	10	10	10	10					
Grand Total										**125**

Question Paper Pattern

1. ISE-I : Marks =10: Unit 1: Multiple Choice Questions
   Online Examination: (1x10)
2. ISE-II: Marks =10: Unit 2 &3: Multiple Choice
   Questions Online Examination: (1x10)
3. Home Assignment I=10 (2x05)
4. Home Assignment II=10 (2x05)
5. ESE: Marks 60 =30 per paper: Unit 1 to 4:
   Multiple Choice questions (1x05=05)
   Attempt any two out of three (1x10=10)
   Attempt any three out of five (3x5=15)

(ISE- Internal Semester Examination, ESE – End Semester Examination)