Rayat Shikshan Sanstha's

Karmaveer Bhaurao Patil College, Vashi, Navi Mumbai

(Empowered Autonomous)

[University of Mumbai]

Syllabus for Approval

Sr. No.	Heading	Particulars
1	**Title of Course**	**S.Y.B.Sc. Chemistry**
2	**Eligibility for Admission**	**F.Y.B.Sc. [of any recognized University]**
3	**Passing marks**	40%
4	**Ordinances/Regulations (if any)**	
5	**No. of Years / Semesters**	**One Year / Two Semesters**
6	**Level**	**U.G.**
7	**Pattern**	**Semester**
8	**Status**	**New (NEP 2020)**
9	**To be implemented from Academic year**	**2024-2025**

AC - / / 2024

Item No –

Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI.NAVI MUMBAI
Sector-15- A, Vashi, Navi Mumbai - 400 703

(Empowered **Autonomous**)

Program: B.Sc.

Syllabus for S.Y.B.Sc. In Chemistry

Course: S.Y.B.Sc. Chemistry

Under NEP 2020

with effect from the academic year

2024-2025

Preamble of the Syllabus:

Bachelor of Science (B.Sc.) in Chemistry is an undergraduate program of the Department of Chemistry, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai. The revised syllabus in Chemistry as per the NEP 2020 structure for S.Y.B.Sc. The course will be implemented from the academic year **2024-2025**.

The NEP 2020 to be implemented through this curriculum would allow students to motivate and encourage learners to understand basic concepts in chemistry and to develop the experimental skills that will provide a strong foundation.

The learners pursuing this course would have to enrich their knowledge through critical/analytical thinking and reasoning abilities, numerical problem solving, hands-on activities, study tours, industrial visits, mini projects etc.

The learner would have to familiarize with the recent scientific and technological advancements and in turn to develop critical and analytical abilities towards understanding of real world problems.

Karmaveer Bhaurao Patil College Vashi, Navi Mumbai

Name of the Faculty: Science and Technology

Name of the Program: Bachelor in Science (B. Sc.)

S. Y. B. Sc. Chemistry
Program Outcomes

PO-1	**Disciplinary Knowledge:** Understand the basic concepts, fundamental principles, theoretical formulations and experimental findings and the scientific theories related to Physics, Chemistry, Mathematics, Microbiology, Computer Science, Biotechnology, Information Technology and its other fields related to the program.
PO-2	**Communication Skills:** Develop various communication skills such as reading, listening and speaking skills to express ideas and views clearly and effectively.
PO-3	**Critical Thinking:** Propose novel ideas in explaining the scientific data, facts and figures related to science and technology.
PO-4	**Analytical Reasoning and Problem Solving:** Hypothesize, analyze, formulate and interpret the data systematically and solve theoretical and numerical problems in the diverse areas of science and technology.
PO-5	**Sense of Inquiry:** Curiously ask relevant questions for better understanding of fundamental concepts and principles, scientific theories and applications related to the study.
PO-6	**Use of Modern Tools:** Operate modern tools, equipments, instruments and laboratory techniques to perform the experiments and write the programs in different languages (software).
PO-7	**Research Skills:** Understand to design, collect, analyze, interpret and evaluate information/data that is relevant to science and technology.
PO-8	**Application of Knowledge:** Develop scientific outlook and apply the knowledge with respect to subject.
PO-9	**Ethical Awareness:** Imbibe ethical, moral and social values and exercise it in day-to-day life.
PO-10	**Teamwork:** Work collectively and participate to take initiative for various field-based situations related to science, technology and society at large.
PO-11	**Environment and Sustainability:** Create social awareness about environment and develop sustainability for betterment of future.
PO-12	**Lifelong Learning:** Ability of self-driven to explore, learn and gain knowledge and new skills to improve the quality of life and sense of self-worth by paying attention to the ideas and goals throughout the life.
Name of the Specific Program: BSc Chemistry Program Specific Outcomes (PSO)	
PSO-1	Enable students to develop scientific skills by applying the principles of organic, inorganic, physical chemistry and analytical chemistry.
PSO-2	To develop ability and to acquire the knowledge of terms, facts, concepts and processes techniques of Chemistry.
PSO-3	To inculcate the ethical, Human, environmental, Social Values and responsibilities in the context of learning Chemistry.
PSO-4	To expose the students to a breadth of experimental techniques, skills required in chemistry, proper handling of apparatus and chemicals using modern instrumentation.

SYLLABUS (UNDER NEP 2020) FOR S. Y. B. Sc. CHEMISTRY

(THEORY & PRACTICAL)

SEMESTER – III (MAJOR & MINOR)		
Course Code	**Title**	**Credits**
CHE201	Physical and Inorganic Chemistry	**03**
CHE202	Organic and Inorganic Chemistry	**03**
CHE203	Analytical Chemistry	**03**
CHEP201	Practicals	**01**
CHEP202	Practicals	**01**
CHEP203	Practicals	**01**
	Total =	**12**
SEMESTER – IV (MAJOR & MINOR)		
CHE251	Physical and Inorganic Chemistry	**03**
CHE252	Organic and Inorganic Chemistry	**03**
CHE253	Analytical Chemistry	**03**
CHEP251	Practicals	**01**
CHEP252	Practicals	**01**
CHEP253	Practicals	**01**
	Total =	**12**

SCHEME OF THEORY (SEE) EXAMINATION (SEM- III & IV)

I.	**Theory: Semester End Examination: 60 % Weightage** Each theory course shall be of TWO hours in duration. Each course shall consist of FOUR questions, one on each Unit. All questions are compulsory and will have internal options. Choice in question papers is 2 times.		
	Q – I :	From Unit – I (12 Marks)	**Total Marks (45M)**
	Q – II :	From Unit – II (12 Marks)	
	Q – III :	From Unit – III (12 Marks)	
	Q – IV :	From Unit – I, II & III (09 Marks)	
II.	**Theory: Continuous Internal Assessment: 40 % Weightage** 1. Online Test (MCQ type) of 20 marks of 20 minutes duration. 2. Evaluation Method (I) : 10 marks 3. Evaluation Method (II): 10 marks		**Total Marks 40 reduced to (30 Marks)**

SCHEME OF PRACTICAL EXAMINATION (SEM- III & IV)

III.	**Practical: Semester End Examination: 25 marks**		
	CHEP201 (Major)	1. One Experiment (20 marks and 2 hrs duration) 2. Certified Journal and Viva-Voce: 05 marks	**Total Marks (25 Marks)**
	CHEP202 (Major)	1. One Experiment (20 marks and 2 hrs duration) 2. Certified Journal and Viva-Voce: 05 marks	**Total Marks (25 Marks)**
	CHEP203 (Minor)	1. One Experiment (20 marks and 2 hrs duration) 2. Certified Journal and Viva-Voce: 05 marks	**Total Marks (25 Marks)**

SEMESTER - III

Course Code	Title of the Courses	Credits
CHE201	Physical and Inorganic Chemistry	3P+1P = 04
CHE202	Organic and Inorganic Chemistry	3T+1P = 04

CHE203	Analytical Chemistry	3T+1P = 04

Vertical 1 -Major Course - 1:

Course Code: CHE201: (45 Lectures Theory + 30 Hrs Practicals, Total Credits = 04)

Unit – 1:	Chemical Thermodynamics-II, Electrochemistry 1.1 Chemical Thermodynamics-II (5L) • 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). 1.2 Electrochemistry: (5L) • 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).	**(10 L)**
Unit – 2:	Chemical Kinetics-II, Solutions 2.1 Chemical Kinetics-II (5L) • 2.1.2 Effect of temperature on the rate of reaction, Arrhenius equation, Concept of energy of activation (Ea). (Numericals expected). • 2.1.3 Theories of reaction rates: Collision theory and activated complex theory of bimolecular reactions. Comparison between the two theories (Qualitative treatment only) 2.2 Solutions: (5 L) • 2.2.1 Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law–non-ideal solutions. Vapour pressure-composition and temperature-composition curves of ideal and non-ideal solutions. • 2.2.2 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 • 2.2.4 Nernst distribution law and its applications, solvent extraction.	**(10 L)**
Unit – 3:	Selected topics on p-block elements **3.1 Chemistry of Boron Compounds (02)** 1. Preparation of simple boranes like diborane and tetraborane. 2. Structure and bonding in diborane and tetraborane (2e-3c bonds) 3. Synthesis and applications of Borax. **3.2 Chemistry of Silicon and Germanium (03)** 1. Silicon compounds: Occurrence, Structure and inertness of SiO_2 2. Preparation of structure of $SiCl_4$ 3. Occurrence and extraction of Germanium 4. Preparation of extra pure Silicon and Germanium	**(10 L)**

	3.3 Chemistry of Nitrogen family (05) 1. Trends in chemical reactivity - Formation of hydrides, halides, oxides with special reference to oxides of nitrogen. 2. Oxides of nitrogen with respect to preparation and structure of NO, NO_2, N_2O and N_2O_4. 3. Synthesis of ammonia by Bosch – Haber process.	

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)
7. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
8. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
9. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
10. Vogel's Textbook of Quantitative Chemical Analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
11. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
12. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
13. Chemistry of Transition Elements Pg.- 608 – 679.14. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.

<u>Vertical -1- Major Course - 2:</u>

Course Code: CHE202: (45 Lectures Theory + 30 Hrs Practicals, Total Credits = 04)

Unit – 1:	**Carbonyl Compounds** **1.1 Carbonyl Compounds and their Reactivity: [10L]** 1.1 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, Riemer-Tiemann Reaction, Vilsmeier Haack reaction 1.2 General mechanism of nucleophilic addition, and acid catalyzed nucleophilic addition reactions.	**(10 L)**

	1.3 Reactions of aldehydes and ketones with NaHSO3, HCN, RMgX, alcohol, amine, phenylhydrazine, 2,4-Dinitrophenyl hydrazine, LiAlH4 and NaBH4. 1.4 Mechanisms of following reactions: Aldol condensation, Knoevenagel condensation, Claisen-Schmidt and Cannizzaro reaction. 1.5 Keto-enol tautomerism: Mechanism of acid and base catalyzed enolization 1.6 Active methylene compounds: Acetylacetone, ethyl acetoacetate diethyl malonate, stabilized enols. Reactions of Acetylacetone and ethyl acetoacetate (alkylation, conversion to ketone, mono- and dicarboxylic acid)	
Unit – 2:	**Reactions and reactivity of halogenated hydrocarbons, alcohols, phenols and epoxides,** **2.1. Reactions and reactivity of hydrocarbons:** 2.1.2. **Aromatic Nucleophilic Substitution [5L]** Reactivity of aryl halides towards nucleophilic substitution reactions. Nucleophilic aromatic substitution (S**N**Ar) addition-elimination mechanism and benzyne mechanism. SN^1 reactions (Sandmeyer reaction) **2.2 Reagents in Organic Synthesis: [5L]** **2.2.1 Oxidizing & Reducing reagents [3L]** Oxidizing Agents (Preparation, reaction and application) PDC, PCC, Swern, Jones regent oxidation, Oppenauer oxidation, Reducing Agents (Preparation, reaction and application) Clemmensen Reduction, Wolff- Kishner Reduction, Birch Reduction, MPV reduction, Barnavont Blanc Reduction 2.2.2 **Organomagnesium and organolithium compounds: [2L]** 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, CO_2, cyanides and epoxides.	**(10 L)**
Unit – 3:	**Chemical Bonding** Directional Bonding: Orbital Approach. (5L) 1. Covalent Bonding: The Valence Bond Theory- Introduction and basic tenets. Interaction between two hydrogen atoms and the Potential energy diagram of the resultant system. Corrections applied to the system of two hydrogen atoms- Formation of H_2. 2. Homonuclear diatomic molecules from He_2 to Ne_2. Resonance and the concept of Formal Charge; Rules for Resonance or Canonical structures.Bonding in Polyatomic Species: The role of Hybridization. Types of hybridization involving d orbitals.dsp^2, sp^3d, sp^3d^2 and sp^3d^3. 3. Equivalent and Non-Equivalent hybrid orbitals. 4. Contribution of a given atomic orbital to the hybrid orbitals (with reference to sp^3 hybridization as in CH_4, NH_3 and H_2O and series like NH_3, PH_3, AsH_3, BiH_3)	**(10 L)**

	2. **Molecular Orbital Theory** (5L) **1.** Comparing Atomic Orbitals and Molecular Orbitals.Linear combination of atomic orbitals to give molecular orbitals (LCAO- MO approach for diatomic homonuclear molecules).Wave mechanical treatment for molecular orbitals (H_2^+ and H_2).Molecular orbital Theory and Bond Order and magnetic property: with reference to O_2,O_2^+ O_2^-,O_2^{2-} (Problems and numerical problems expected wherever possible)	

Reference Books:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
3. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry CengageLearning India Pvt.Ltd., New Delhi (2009).
4. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
5. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co., NewYork (1985).
6. K.L.Kapoor A textbook of Physical Chemistry3rd Ed. vol.1,2Macmillan Publishing Co., NewDelhi(2001)
7. Practical Inorganic Chemistry by G. Marr and B. W. Rockett van Nostrand Reinhold Company (1972)
8. Inorganic Chemistry – Gary Wulfsberg, Viva Book, First Indian Edition 2002
9. Quantitative Analysis – R.A.Day, A.L. Underwood, sixth edition
10. Vogel's Textbook of Quantitative Chemical Analysis – J Mendham, R C Denny, J D Barnes, M Thomas, B Sivasankar
11. Bruce H. Mahan, University Chemistry, Narosa publishing house pg. 611 to 683.
12. R. Gopalan , Universities Press India Pvt.Ltd. Inorganic Chemistry for Undergraduates.
13. Chemistry of Transition Elements Pg.- 608 – 679 .
14. J. D. Lee, 4th Edn., Concise Inorganic Chemistry, ELBS, The group III elements Pg. 359- 648.

Vertical 2-Analytical Chemistry(Minor) Code-CHE203

Unit – 1:	**Treatment of analytical data and sampling** **1. Sampling (05L)** • Definition and purpose of Sampling, Types of Sampling, • Sampling of liquids: Homogeneous (Static), Heterogeneous (Static immiscible) and flowing liquids. **2. Sampling of solids:** Sample size, size reduction, Different sampling equipment. **3. Treatment of Analytical Data (05L)** • Types of errors, Precision and Accuracy in Analysis, Corrections for Determinate Errors **4. Concept of Confidence limits and confidence interval and its computation using** • Population standard deviation, Student's test, Range	**(10 L)**

Unit – 2:	**Unit - Classical Methods of Analysis** 1. Gravimetric analysis (05L) General Introduction to Gravimetry. Types of Gravimetric Methods, Precipitation Gravimetry, Steps involved in gravimetric analysis, Role of Digestion, Filtration, Washing, Drying Ignition of precipitate. 2. Methods of separation: Solvent extraction (05 L) Introduction, Nernst distribution Law, Distribution Ratio, Partition Coefficient, Single-step and multi-step extraction, Percentage extraction for single-step and Multistep extraction. Batch and continuous extraction (Numericals are expected)	**(10 L)**
Unit – 3:	**Modern Approach Chemical Industrial** **1. Basic Approach to Chemical Industry** Introduction, basic requirements of chemical industries, chemical production, raw materials, unit process and unit operations, Quality control, quality assurance, process control, research and development, pollution control, human resource, safety measures, classification of chemical reactions, batch and continuous process, Conversion, selectivity and yield, copyright act, patent act, trademarks **2. Fermentation Industry: (05)** Introduction, importance, the Basic requirement of the fermentation process, Manufacture of industrial alcohol from molasses, fruits, food grains, & ethylene, Manufacturing of wine, beer, whisky, and rum from molasses.	**(10 L)**

References: 1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K. Anandpp2.107-2.148.

2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp143-172.

3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp118-181.

4. Instrumental Analysis by Douglas A. Skoog,F. James Holler, Stanley R.Crouch

5. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle,7thEdition

6. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education

7. Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition, chapter 13, 14 and 15

8. Day and Underwood, “Quantitative analysis" prentice hall 1991, chapter3

9. S.M. Khopkar, “Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher

10. Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley Students Edition, Chapter No8,9,10

11. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch

12. Modern Analytical Chemistry , David Harvey (page numbers 232-265)

13. Handbook of Industrial Chemistry by Cory Simmons

14. Industrial Chemistry by Dr. Darshan V Chaudhary

15. Fundamentals of Industrial Chemistry by John A. Tyrell

16. Industrial Inorganic Chemistry by Mark Anthony Benvenuto
17. Organic Chemistry Principles and Industrial Practice by Mark M. Green, Harold A. Wittcoff
18. Industrial Chemistry by Mr Ravi S Tank

Practical Laboratory Course (CHEP201and CHEP202)

List of Experiments: 08 (Min. 06 to be completed)

Chemistry Practicals:

I- Physical Chemistry

1. To verify Ostwald's dilution law for weak acid conductometrically.

2. To determine the dissociation constant of weak acid conductometrically.

3. To determine the critical solution temperature (CST) of phenol - WaterSystem.

4. Determination of energy of activation of acid-catalyzed hydrolysis of methyl acetate.

5. To investigate the reaction between K2S2O8 and KI with equal initial concentrations of the reactants.

6. To determine the solubility of sparingly soluble salts (any two) conductometrically.

II-Inorganic Chemistry

1. 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)]

2. Crystallisation of potassium iodate and to estimate its purity before and after the separation.

3. Estimation of total hardness

4. Investigation of the raction between Copper supfate and Sodium Hydroxide (Standard EDTA solution to be provided to the learner).

III-Organic Chemistry

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 (Any eight preparations)

A minimum **06** experiments for **EACH course** from the list should be completed in **SEM – III** and to be reported in the journal. A certified journal is a must to be eligible to appear for the semester-end practical examination. For practical examinations, the learner will be examined for **ONE experiment in each course.** The scheme of examination for the revised course in Chemistry at the Second Year B.Sc. Semester end examination will be as mentioned above. The duration of the practical examination will be of **2 hrs for each course.**

The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of the subject.

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 th Chemistry, 5 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

CHEP203 Practical in Basics in Analytical Chemistry

1. Tools of Analytical Chemistry-I:

a) Analytical glass wares like burettes, pipettes, Standard flasks, Separating funnels.

b) Weighing tools such as two pan balance and mono pan balance, digital balances:

c) Incineration devices: Burners, Electrical Incinerators, Muffle Furnace,

d) Drying Devices: Hot Air Oven, microwave oven, Desiccators, Vacuum desiccators

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, the various steps 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 a given Solution by using calibration curve method and calculation of % error. (The learner is expected to learn the relation between concentration and Absorbance, to draw a calibration curve, use the slope of the calibration curve 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)

<u>Vertical 3- OPEN ELECTIVE (OE)</u> -Course - 4

Course Code: CHE204: (30 Hrs Practicals, Total Credits = 02 credits)

Learning Outcome:

After successful completion of the course, students will be able to:

- The adulteration of common foods and their adverse impact on health
- Comprehend certain basic skills of detecting adulteration in common foods.
- Extend their knowledge of detecting other kinds of adulteration.

CO-PO-PSO Mapping
Semester-III
Open Elective Course: Fundamentals of Food Adulteration
After successful completion of course in cosmetic chemistry a learner should be able to: CO-1 To understand chemistry behind food adulteration. [2] * CO-2 To evaluate the amount of adulteration in given beverage product. [4] CO-3 To describe various methods to detect adulteration. [2] CO-4 To understand the health hazards of different adulterant materials in food materials [2]
ICT Tools: Videos, PPT, Smart Board
Students Centric Methods: Experimental, Participative, Problem Solving
The CO-PO Mapping Matrix

CO\ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	P O8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO-1	2	-	-	2	2	-	-	-	-	-	-	-	2	2	-	-
CO-2	2	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3	1	2	-	-	-	-	-	-	-	-	-	-	-	2	1	
CO-4	1	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-

***Note: [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

Fundamentals of Food Adulteration

Food Adulteration Practices Laboratory Practicals (2credits)

Adulteration-Definition; types-Intentional, incidental, metallic, and packaging hazard. Causes and methods of food adulteration. General Impact on Human Health. Detection and Prevention of Food Adulteration. Mitigation measures for addressing food adulteration.

Food additives- Definition, classification, role of additives in processed foods. Safe levels of additive uses and the institutions involved in the process.

Explanation to be followed by practicals

Adulteration of Common Foods and Methods of their Detection

1. Composition and adulterant detection in the following Foods- Milk, Edible Oil, Sugar, Spices, honey, flours, Ghee Beverages- Alcoholic and Non-Alcoholic. (one method of detection for each food item).
2. To detect the adulterants like paraffin wax/hydrocarbons, dyes and argemone in the fats, oils and ghee.
3. To detect the presence of adulterants like water, proteins, urea, formalin, detergent, sugar

and starch in the milk.

4. To detect the adulteration of insoluble substance, chalk powder and washing soda in sugar.
5. To detect the adulteration of red lead salts/brick powder in chili powder, yellow lead salts/ colored saw dust in turmeric and dried papaya seeds in pepper.
6. To detect sugar as an adulterant in honey.

Reference books:

1. A first course in Food Analysis, A.Y. Sathe, New Age International (P) Ltd., 1999.
2. Food Safety, case studies – R. V. Bhat, NIN, 1992.
3. DART- Detect adulteration with rapid test. FASSAI, Imprinting Trust, assuring safe and nutritious food, Ministry of Health and Family Welfare, Government of India.
4. Rapid detection of food adulterants and contaminants Theory and Practice, S. N. Jh, 2016, Kindle Edition.
5. Domestic Tests for Food Adulterations, H. G. Christian, Forgotten books.
6. A Laboratory Manual of Food Analysis, S. Sehgal, Wiley Publishers.

Food Safety and Standards Act, 2006. Bare ACT, November 2020, Commercial law publishers

<u>Vertical -4-Vocational Skill Course (VSC) -course 5:</u>

Course Code: CHE205: (60 Hrs Practicals, Total Credits = 02 credits)

Course Name :Forensic Chemistry

Course Outcomes (COs): After completing this course, the students should be able to …
"Forensic Chemistry"

Course Outcomes:

1. To understand the basic principles and applications of forensic chemistry
2. To learn various analytical techniques used in forensic chemistry
3. To acquire practical skills in handling and analyzing forensic samples
4. To develop critical thinking and problem-solving abilities in forensic chemistry
5. To appreciate the ethical and legal aspects of forensic chemistry

Syllabus-Theory & Practical
Name of the Course: Value Added Certificate course in Applied Forensic Chemistry

Theory

Unit I : Forensic Toxicology (10 lectures)

1.1 Introduction and Concept Of Forensic Toxicological Examination And Its Significance.
1.2 Forensic Pharmacology and Forensic Toxicology, Drugs and Poisons, Pharmacokinetics, Absorption, Distribution, Metabolism and Elimination.
1.3 Pharmacodynamics, Identification of drugs in the body, Immunoassay techniques
1.4 Forensic Toxicology of Ethyl Alcohol, Pharmacokinetics of Ethanol, Analysis of Alcohol in Breath

Unit II: Fires and Explosives (10 lectures)

2.1 Introduction to Fire and Explosives and Case Study
2.2 Conditions for a fire, Types of fires, analysis of fire scene residue evidence
23 Analysis of Fire Scene Accelerant Residues by Gas Chromatography, Interpretation and Association of Fire Scene Evidence.
2.4 Effects of Explosives, Types of Explosives, High and Low order Explosives, Explosive Trains, Analysis of Explosives.

Unit-II: Project /field visit/Practical (10 Lecture)

Reference

1. Introduction to Forensic Science in Crime Investigation By Dr.(Mrs.) Rukmani Krishnamurthy
2. Henry Lee's Crime Scene Handbook by Henry C Lee
3. Forensic Biology by Shrikant H. Lade
4. Crime Scene Processing and Laboratory Work Book by Patric Jones
5. Forensic Science: An Introduction to Scientific and Investigative Techniques 3rd ed. by Stuart H. James
6. Fundamentals of Forensic Science by Max M. Houck, Jay A. Siegel

<u>Vertical :5-– (IKS)</u> INDIAN KNOWLEDGE SYSTEM (IKS) -Course 6:

Course Code: CHE206: (30 Lectures Theory, Total Credits = 02 credits)

Course Outcomes (COs): After completing this course, the students should be able to …

CO - 1: The core ideas behind Indian Knowledge Systems.

CO - 2: To think critically and compare old Indian science with modern science, understanding how different kinds of knowledge connect.

CO - 3: To know how ancient India approached environmental care.

CO - 4: To understand how ancient Indian knowledge can enhance modern science, especially in Chemistry.

IKS Induction Program Module for Chemistry and Metallurgy (2 credits)

Unit 1: (15L)

Introduction to IKS in general; introduction to a few terms along with the IAST transliteration scheme with diacritic marks.(IAST- International Alphabet of Sanskrit Transliteration)

Outline of the contributions of ancient and medieval Indians in the area of chemistry and metallurgy as gleaned from archaeological artifacts, temple icons and other such tangible objects like the Delhi Iron Pillar that have survived the test of time.

Specific use, processing, and finishing of 6 metals since the Vedic times and how the knowledge constantly evolved to incorporate other metals like mercury and zinc at later periods

Unit 2: (15L)

Chemistry of dyes, pigments, and other coloring materials used in paintings, fabrics, beads, and other day-to-day utilities since ancient times and their constant evolution through different periods. Chemistry in Ayurvedic texts as well as in Ayurveda practice. A few case studies on the preparation, quality control, and delivery of herbs-mineral drug formulations. Introduction to select original texts about chemistry and metallurgy like the Rasāṛṇava and Rasaratnasamuccaya; dwelling on the style of writing a technical subject as well as on the content that are in vogue in contemporary chemistry.

References Text Books:

1. R.M. Pujari, Pradeep Kolhe, N. R. Kumar, 'Pride of India: A Glimpse into India's Scientific Heritage', Samskrita Bharati Publication.
2. 'Indian Contribution to science', compiled by Vijnana Bharati.
3. 'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

Reference Books:

1. Dr. Subhash Kak , Computation in Ancient India,Mount, Meru Publishing (2016)
2. Dharampal, Indian Science and Technology in the Eighteenth Century, Academy of Gandhian Studies, Hyderabad, 1971, republ. Other India Bookstore, Goa, 2000
3. Robert Kanigel, The Man Who Knew Infinity: A Life of the Genius Ramanujan, Abacus, London, 1999
4. Alok Kumar, Sciences of the Ancient Hindus: Unlocking Nature in the Pursuit of Salvation, CreateSpace Independent Publishing, 2014
5. B.V. Subbarayappa, Science in India: A Historical Perspective, Rupa, New Delhi, 2013
6. S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, Jnana Deep Publications, Bangalore, 3rd edn, 2004
7. S. Balachandra Rao, Vedic Mathematics and Science In Vedas, Navakarnataka Publications, Bengaluru, 2019
8. Bibhutibhushan Datta, Ancient Hindu Geometry: The Science of the Śulba, 1932, repr. Cosmo Publications, New Delhi, 1993
9. Bibhutibhushan Datta & Avadhesh Narayan Singh, History of Hindu Mathematics, 1935, repr. Bharatiya Kala Prakashan, Delhi, 2004
. George Gheverghese Joseph, The Crest of the Peacock, Penguin Books, London & New Delhi, 2000
11. J. McKim Malville & Lalit M. Gujral, Ancient Cities, Sacred Skies: Cosmic Geometries and City Planning in Ancient India, IGNCA & Aryan Books International, New Delhi, 2000).
12. Clemency Montelle, Chasing Shadows: Mathematics, Astronomy and the Early History of Eclipse Reckoning, Johns Hopkins University Press, 2011

13. Anisha Shekhar Mukherji, Jantar Mantar: Maharaja Sawai Jai Singh's Observatory in Delhi, AMBI Knowledge Resources, New Delhi, 2010
14. Thanu Padmanabhan, (ed.), Astronomy in India: A Historical Perspective, Indian National Science Academy, New Delhi & Springer (India), 2010
15. Acharya Prafulla Chandra Ray, A History of Hindu Chemistry, 1902, republ., Shaibya Prakashan Bibhag, centenary edition, Kolkata, 2002
16. R. Balasubramaniam, Delhi Iron Pillar: New Insights, Indian Institute of Advance Study, Shimla & Aryan Books International, New Delhi, 2002
17. R. Balasubramaniam, Marvels of Indian Iron through the Ages, Rupa & Infinity Foundation, New Delhi, 2008 11 Guidelines for Training/ Orientation of Faculty on IKS
18. Anil Agarwal & Sunita Narain, (eds), Dying Wisdom: Rise, Fall and Potential of India's Traditional Water-Harvesting Systems, Centre for Science and Environment, New Delhi, 1997
19. Fredrick W. Bunce: The Iconography of Water: Well and Tank Forms of the Indian Subcontinent, DK Printworld, New Delhi, 2013 12

Vertical :6- (FP) FIELD PROJECTS (FP) – Course -7:

Course Code: CHE207: (120 Hrs, Total Credits = 04 credits)

SEMESTER - IV

Vertical	Course Code	Title of the Courses	Credits
Vertical 1 Major	CHE251	Physical and Inorganic Chemistry	3P+1P = 04
	CHE252	Organic and Inorganic Chemistry	3T+1P = 04
Vertical 2	CHE253	Analytical Chemistry	3T+1P = 04

Minor			

Vertical:1- Major Course -1-Physical and Inorganic Chemistry

Course code :CHE251 (Credits-3T+1P) (45 Lectures Theory + 30 Hrs Practicals, Total Credits = 04

Unit – 1:	**1.1.Electrochemistry-II: (5L)** Electrochemical conventions, Reversible and irreversible cells. Nernst equation and its importance, Types of electrodes, Standard electrode potential, Electrochemical series (Numericals expected). Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. (Numericals expected) **1.2 Phase Equilibria: (5L)** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Phase diagrams of one-component systems (water and sulphur).Two-component systems involving eutectics, congruent and incongruent melting points (lead-silver system). Three-component System –Introduction with diagrammatic representation.	**(10 L)**
Unit – 2:	**Solid-State Chemistry and Catalysis** **2.1 Solid State Chemistry: (5 L)** Recapitulation of laws of crystallography and types of crystals, Characteristics of simple cubic, face-centered cubic and body-centered cubic systems, interplanar distance in the cubic lattice (only expression for the ratio of interplanar distances are expected. 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) **2.2 Catalysis: (5 L)** Types of catalysis, catalytic activity, specificity and selectivity, inhibitors, catalyst poisoning and deactivation.Mechanisms and kinetics of acid-base catalyzed reactions, effect of pH. Mechanisms and kinetics of enzyme-catalyzed reactions (Michaelis-Menten equation).Effect of particle size and efficiency of nanoparticles as catalyst.	**(10 L)**
Unit – 3:	**Comparative Chemistry of the Transition Metals and Coordination Chemistry (5L** **Comparative Chemistry of the transition metals** Origin of color 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).Magnetic properties of transition metal compounds: Origin of magnetism-spin and orbital motion of electrons; equation for spin only and	**(10 L)**

	spin-orbital magnetism in terms of Bohr magnetons (No derivation of relevant equations expected) Reasons for quenching of orbital moments. **2. Coordination Chemistry : (5 L)** **Introduction to Chemistry of Coordination Compounds** **1.** Historical perspectives: Early ideas on coordination compounds Basic terms and nomenclature.Types of ligands,4. Isomerism: Types of Structural Isomerism. Evidence for the formation of coordination compounds. 2.Theories of coordination compounds: Werner's Theory of coordination compounds, Effective atomic number rule. Nature of the Metal-Ligand Bond:Valence Bond Theory; Hybridization of the central metal orbitals- sd^3/d^3s sp^3d^2/d^2sp^3, sp^2d.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) • Limitations of V.B.T	

Major Course - 2: Organic and Inorganic Chemistry

Course Code: CHE252: (45 Lectures Theory + 30 Hrs Practicals, Total Credits = 04)

Unit – 1:	**1.1 Carboxylic Acids and their Derivatives: (10 L)** Nomenclature, structure and physical properties, acidity of carboxylic acids, effects of substituents on acid strength of aliphatic and aromatic carboxylic acids. Preparation of carboxylic acids: oxidation of alcohols and alkyl benzene, carbonation of Grignard and hydrolysis of nitriles. Reactions: Acidity, salt formation, decarboxylation, Reduction of carboxylic acids with $LiAlH_4$, diborane, Hell- Volhard-Zelinsky reaction, Conversion of carboxylic acid to acid chlorides, esters, amides and acid anhydrides and their relative reactivity. Mechanism of nucleophilic acyl substitution and acid-catalyzed nucleophilic acyl substitution. Interconversion of acid derivatives by nucleophilic acyl substitution.. Mechanism of Claisen condensation and Dieckmann condensation.	**(10 L)**
Unit – 2:	Unit II: Amines, dizonium salts :Nitrogen containing compounds 2.1 Amines: (5 L) • Nomenclature, the effect of substituent on the basicity of aliphatic and aromatic amines; 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.	**(10 L)**

	• 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. 2.2.Diazonium Salts: (5 L) • Preparation and their reactions/synthetic application - Sandmeyer reaction, Gattermann reaction, Gomberg 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.	
Unit – 3:	**1. Ions in aqueous medium (08 L)** Acidity of Cations and Basicity of Anions • Hydration of Cations; Hydrolysis of Cations predicting degree of hydrolysis of Cations-effect of Charge and Radius. • Latimer Equation. Relationship between pKa, acidity and z^2/r ratios of metal ions graphical Presentation • Classification of cations on the basis of acidity category – Non acidic, Moderately acidic, strongly acidic, very strongly acidic with pKa values range and examples • Hydration of Anions; Effect of Charge and Radius; Hydration of anions-concept, diagram classification on the basis of basicity **2. Uses and Environmental Chemistry of volatile Oxides and oxo-acids (02 L)** • Physical properties of concentrated oxo-acids like sulfuric, Nitric and Phosphoric acid • Uses and environments aspects of these acids	**(10 L)**

Reference Books:

1. Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.
2. (Pearson Education).2012
3. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson
4. Education).
5. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural
6. Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
7. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India
8. Edition, 2013.
9. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University
10. Press.
11. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
12. Comprehensive Organic Chemistry- The synthesis and reactions of Organic Compounds,
13. Derek barton ,W. David Ollis.

14. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
15. Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London,
16. 1994.
17. Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005

Vertical:2- Minor- Course -3 Course name- Analytical Chemistry

Course code-**CHE253 -(Credits-3T+1P)**

(45 Lectures Theory + 30 Hrs Practicals, Total Credits = 04

Unit – 1:	**Basic Concepts in Instrumental methods** 1.1. Optical methods. • Statement of Beer's Law and Lambert's Law, Combined Mathematical Expression 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)Block Diagrams for Single beam Colorimeter, and Spectrophotometer (Construction and working-Details of Components expected) **1.2. Potentiometry:** • Principle.:Role of Reference and indicator electrodes **1.3. pH metry:** Principle, Construction Working of Combined Glass electrode **1.4 Conductometry:** Principle, Conductivity cell and its construction, Applications in Neutralization Titrimetry with respect to Strong Acid-Strong Base,Strong Acid-Weak Base,Strong Base-weak Acid	**(10 L)**
Unit – 2:	**Miscellaneous methods and environmental (05)** **2.1 Thermal methods** • Introduction, Different thermal events, and classification based on different interactions. Principle, instrumentation and applications of • Thermogravimetric Analysis (TGA) Differential Thermal Analysis (DTA) **2.2 Environmental analysis (05)** **(Basic relations and formulae are expected)** • Soil analysis, important parameters of soil testing namely, i) Cation exchange capacity (CEC), ii) Organic matter, iii) SAR (Sodium Absorption Ratio), iv) Soil pH v) EC (Electrical Conductivity) • Water analysis, i) pH ii) Total Dissolved Solids (TDS) iii) Hardness iv) Biological Oxygen Demand (BOD) v) Chemical Oxygen Demand (COD) vi) E. Coli (Escherichia coli)	**(10 L)**

Unit – 3:	**Industrial Chemistry (10 L)** **1. Operation -Distillation (05L)** • Introduction ,Fractional distillation ,Azeotropic distillation Vaccum distillation,Extractive distillation **2. Petrochemicals and eco-friendly fuels (05L)** • Introduction, occurrence, composition of petroleum, resources, processing of petroleum, calorific value of fuel, cracking, octane rating (octane number), cetane number, flash point, and petroleum refineries, applications of petrochemicals, synthetic petroleum, lubricating oils & additives.Fuels and eco-friendly fuels: liquid, gaseous fuel (LPG, CNG), fossil fuels, diesel,Bio-diesel, gasoline, aviation fuels. Use of solar energy for power generation.	**(10 L)**

References

1. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal , Sham K. Anandpp2.107-2.148.
2. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp143-172.
3. Instrumental Methods of Analysis by Willard, Merritt, Dean, Settle 7th Edition pp118-181.
4. Instrumental Analysis by Douglas A. Skoog,F. James Holler, Stanley R.Crouch
5. Instrumental methods of analysis by Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle,7thEdition
6. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch.
7.Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education
8.Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition,
9;Day and Underwood, “Quantitative analysis" prentice hall 1991, chapter3
10. S.M. Khopkar, “Basic Concepts of Analytical Chemistry”, IInd Edition NewAge International Publisher
11. Gary D. Christan,” Analytical Chemistry”, VIth Edition, Wiley Students Edition, Chapter No8,9,10
12. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Holler, S. R. Crouch
13. Modern Analytical Chemistry , David Harvey (page numbers 232-265)
14. Handbook of Industrial Chemistry by Cory Simmons
15. Industrial Chemistry by Dr. Darshan V Chaudhary
16. Fundamentals of Industrial Chemistry by John A. Tyrell
17. Industrial Inorganic Chemistry by Mark Anthony Benvenuto
18. Organic Chemistry Principles and Industrial Practice by Mark M. Green, Harold A. Wittcoff
19. Industrial Chemistry by Mr Ravi S Tank

Practical Laboratory Course

(Major- CHEP251and CHEP252)

I-Physical Chemistry

1. To determine standard EMF and the 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 studying kinetics of acid hydrolysis of methyl acetate.

6. Industrial visit report.

II- Inorganic Chemistry

1. Inorganic preparation – Nickel dimethyl glyoxime using microscale method.

2. Complex cation – Tris (ethylene diamine) nickel (II) thiosulphate.

3. Complex anion – Sodium Hexanitrocobaltate (III) The aim of this experiment is to understand the preparation of a soluble cation (sodium)and a large anion hexanitrocobaltate (III) and its use to precipitate a large cation (potassium)

4. Inorganic salt – Calcium or magnesium oxalate using PFHS technique

III -Organic Chemistry

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

1. Prelimenary examination

2. Solubility profile

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. Students are expected to write balanced chemical reactions wherever necessary. (Minimum 6 compounds to be analyzed)

A minimum **06** experiments for **EACH course** from the list should be completed in **SEM – III** and to be reported in the journal. A certified journal is a must to be eligible to appear for the semester-end practical examination.

For practical examinations, the learner will be examined for **ONE experiment in each course.** The scheme of examination for the revised course in Chemistry at the Second Year B.Sc. Semester end examination will be as mentioned above. The duration of the practical examination will be of **2 hrs for each course.**

The questions on slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of the subject.

Practical for Minor course (Basics in Analytical Chemistry)

1. Demostration to Tools of Analytical Chemistry

a. Filtration Flasks, Funnels, Separating Funnels, Distillation apparatus, 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 anyone or use of a 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 and b) and Principle, Construction care and Uses of items (c) to (f) in his journal.)

2. Paper chromatography: Separation of cations like Fe (III), Ni (II) and Cu (II) in a sample. 3. Separation of a solute between two immiscible solvents to determine the distribution ratio and/or extraction efficiency. (Solutes could be as their aqueous solutions and the organic solvent ethyl acetate) Suggested solute for the distribution study: Fe (III) in aqueous solutions. (The learner is expected to learn the technique of solvent extraction by using a separating funnel, method to estimate the concentrations of the solute distributed in the two immiscible phases, determination of the extraction efficiency)

4. Estimation of concentration of Iron from a given sample calorimetrically by using 1,10 phenanthroline.(The learner is expected to learn the handling of the colorimeter).

5. Estimation of Fe (II) in the given solution by titrating against $K_2Cr_2O_7$ potentiometrically and calculation of % error. (The learner is expected to learn the handling of the potentiometer, use of Platinum electrode and reference electrode like SCE. They will learn to determine endpoint 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.) (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.)

REFERENCES:

1. D.A. Skoog, D.M. West, F.J. Holler, and S.R. Crouch, Analytical Chemistry: An Introduction,7th ed., Chapter 15, pp. 345-381.

2. A.I. Vogel."Text book of Quantitative Inorganic Analysis", Longman, London (1961).

3. R.V. Dilts."Analytical Chemistry. Methods of Separation", van Nostrand, N.Y.(1974).

4. Some Experiments for B. Tech in Chemistry & Chemical Technology compiled by Prof. J.B. BARUAH, Mrs. Abhilasha Mohan Baruah and Mr. Parikshit Gogoi

Vertical :3- OPEN ELECTIVE (OE)

Course - 4: Course Name -Chemistry in Agrochemicals

Course Code: CHE254: (30 Hrs Practicals, Total Credits = 02 credits)

Course Outcomes (COs): After completing this course, the students should be able to …

Objective: Conventional insecticides are synthetic chemicals used for quick killing and effective control of insect populations. Biopesticides tend to be highly targeted to specific pests while conventional insecticides allow farmers to control numerous pests with one agrochemical only.

Course Learning Outcomes: Students will be able to learn about the various types of synthetic pesticides available in the market and their selective mode of action on insect populations They can promote the future use of insecticides as metabolic inhibitors in insect physiological research. As a result both the pesticides and the plant sciences get a boost

Theory (1 credit- 15L)

1.1.General introduction and scope, meaning, and examples of insecticides, herbicides, fungicides, rodenticides, pesticides, and plant growth regulators.
1.2. Advantages and disadvantages of agrochemicals
1.3. Synthesis and applications of IAA(Indole Acetic acid) and Endosulphan.
1.4. Biopesticides-Neem oil and Karanj Oil
1.5. Organochlorine Insecticides: Synthesis, nomenclature, structure activity relationship (SAR), mode of action, benefits and adverse effects of the following Organochlorines: DDT, Gammaxene, Chloridane, Hptachlor, Aldrin and Endosulfan.

Practical: (1 credit)

1. To carry out a market survey of potent pesticides (five or more) with details as follows:

a) Name of pesticide

b) Chemical name, class and structure of pesticides

c) Type of formulation available and Manufacturer's name

d) Useful information on the label of packaging regarding Toxicity, LD50 ("Lethal Dose, 50%"), Side effects and Antidotes.

2. Preparation of simple Organochlorine pesticides.

3. To calculate acidity/alkalinity in a given sample of pesticide formulation as per BIS specifications.

5. Data collection : Agrochemicals and their impact on human health:

References:

1. Insecticides in Agriculture and Environment, Perry, A.S., Yamamoto, I., Shaaya, I., Perry, R., Narora Publishing House.
2. Carbamate Insecticides, Chemistry, Biochemistry and Toxicology, Kuhr, R.J., Derough, H.W., CRC Press.
3. Insecticide, Action and Metabolism, O'Brien, R.D., Academic Press, New York and London.
4. Chemical Pesticides: Mode of Action and Toxicology, Stenersen, J., CRC, 2004. Practical:
5. Agrochemicals preparation and mode of action, Cremlyn, R.J.W
6. https://www.mcgill.ca/pfss/files/pfss/agrochemicals_and_their_impact_on_human_health.pdf

Vertical:4-VSC- Course Name: Chemistry of Perfumes:

Vocational Skill Course (VSC) - 5:

Course Code: CHE255: (60 Hrs Practicals, Total Credits = 02 credits)

Course Outcomes (COs): After completing this course, the students should be able to

Perfumes are a mixture of fragrant essential oils or aroma compounds (fragrances), fixatives and solvents, usually in liquid form, used to give the human body, animals, food, objects, and living spaces a pleasant scent.

Perfumes are essentially a blend of complementary ingredients and essential oils. Therefore, perfumes are complex combinations of natural and/or man-made substances that are added to many consumer products to give them a distinctive smell. The salient feature of this program is the emphasis being laid on the overall development of student with a major focus on application and filed work.

Perfume Chemistry, Learning of analytical techniques used in cosmetic and perfume industries etc. Students will get many opportunities interactions with experts in these fields during the course tenure. The students can gain hands-on experience in the field while doing internships in industries/research institutes/health sectors etc. Course Objectives: To provide the learner with knowledge of cosmetics and perfumes with respect to the types of formulations, evaluation and regulatory aspects.

Course Outcome: Upon completion of the course, the learner shall be able to:

1. Discuss the various raw materials for cosmetics and perfumes.

2. Understand the toxicological aspects.

3. Discuss the various cosmetics products w.r.t. raw materials, large scale manufacture. and functional and physiochemical evaluation.

4. Know the regulatory guidelines and sensorial assessment for cosmetics

Unit I

Content Introduction, history, classifications and sources of cosmetics and perfumes Surfactants and their types; Additives (thickeners, foam stabilizers, pearlescent agents, conditioning agents, etc.) Oil componcnts; Waxes, Silhcone Chemistry oils; Cream bases; Emulsifiers; Humectants; Acrosol Propcllants. and production of essential oils with special reference to the following, Eugenol, Geraniol, Sandalwood oil, cucalyptus oil, rosce oil, Jasmone, Civet one, Muscone.

Psychological benefits, fragrance and mood, aromatic substances, types of aromatic substances, chemical constituents of aromatic substances, odours of substances from vegetable, animal and artificial origin

Suggested Continuous Evaluation Methods: Students can be evaluated on the basis of score obtained in a mid-term exam, together with the performance of other activities which can inchude short exams, in-class or online tests, home assignments, group discussions or oral presentations.

Unit II

Essential Oils fixatives - Sandal wood, lemon, cinnamon, patchouli oil, Phenyl acetaldehyde, vanillin. d. Synthetics fixatives Diethyl phthalate Benzyl- Benzoate, alcohols Acetophenone, musk-ketone, musk- Ambrette, Heliotropin, hydroxy citronellal, indole

Suggested Readings:

1. Earnest Guenther, "The Essential Oils" vol. I Robert E. Kreiger Publishing Co. Huntington, New York, 1972.

2. M.S. Balsem, S.D. Genshon, M.M. Rieger, E. Sagarin, S.J. Strianase, "Cosmetics, Science and Technology, Vol. I, II and II, Wiley-Interscience, A Division of John Wiley and Sons., Inc., New York, London, Sydney, Toronto, 1972, Ed. By M.S. Balsam and M.S. Sagarin.

3. Paul Z. Bedoukian, "Perfumery and Flavouring Synthetics" II Edn, Elsevier Publishing Co., Amsterdam, London, New York, 1967.

4. J. Stephan Jellinick," Formulation and Functions of Cosmetics", Wiley Interscience, a Division of John Wiley & Sons., Inc.

5. Mareel IBillot, F.V. Wells," Perfumery Technology" Ellis Harwood Ltd., Halrted Press, a Division of John Wiley & Sons., Inc. New York, London. 1975.

Practical

Preparation of Standard solutions: 1 Normal, I Molar, % w/v solution, % v/v solution.

Standardization of volumetric apparatus.

Analysis of heavy metals- Lead and Mercury.

Determination of chlorides and sulphates.

Paper and Thin Layer Chromatography

Vertical 5:INDIAN KNOWLEDGE SYSTEM (IKS) – Course 6:

Course Code: CHE256: (30 Lectures Theory, Total Credits = 02 credits)

Course Outcomes (COs): After completing this course, the students should be able to …

CO - 1:	The core ideas behind Indian Knowledge Systems.
CO - 2:	To think critically and compare old Indian science with modern science, understanding how different kinds of knowledge connect.
CO - 3:	To know how ancient India approached environmental care.
CO - 4:	To understand how ancient Indian knowledge can enhance modern science, especially in Chemistry.

Chemistry in India Vatsyayana, Nagarjuna, Khanda, Al-Biruni, Vagbhaṭa –building of the ras-shala (laboratory), working arrangements of ras-shala, material and equipment, Yaśodhara Bhaṭṭa-process of distillation, apparatus, saranasamskara, saranataila.

Ancient Indian Chemistry Course type: IKS No. of Credits: 2

Course Outcomes After the completion of this course, students will be able to

CO1: know the Indian Knowledge System, Indian Knowledge system, Chemistry in India, Chemical in Practical Arts and Contribution of Indians.

CO2: understand the Indian Knowledge System and ancient Indian Chemistry.

CO3: relate the various concepts of ancient Chemistry with modern Chemistry.

CO4: describe the concepts of ancient Indians Chemistry.

CO5: justify the role of Indians in the development of Chemistry.

CO6: summarize the Ancient Indian Chemistry.

Course Content

Chapter 1**: Introduction to the Indian Knowledge System** [10hours]

Part 1 – Indian Knowledge System:

An Introduction: Indian Knowledge System: An Overview, The Vedic Corpus Philosophical Systems, Wisdom through the Ages

Part 2: Concepts of Science and Technology:

Linguistics, Number System and Units of Measurement, Knowledge: Framework and Classification

Chapter -2**: Chemistry in India** [10 hours]

Introduction,

Pre-Vedic period, The Vedic age and Post-Vedic period and the Classical age, Alchemy, Indian Alchemy and its characteristics, possible origin of Indian Alchemy, Laboratory and Apparatus, the Chemical Laboratory at Presidency College, the Institutional Home of the Indian School of Chemistry, the School of Indian Chemistry

Chapter -3: Chemical in Practical Arts [10 hours]

Introduction, Metallurgy and working of metals: Zinc (Zn), Mercury(Hg), Gold (Au), Silver (Ag), Copper (Cu), Bronze and Brass, and iron (Fe), Tinning and alloying, enameling, recovery of gold (Au) from wastage of gold(Au) working, gunpowder, saltpeter, mineral acid, alum and green vitriol, paper, ink, soap, cosmetics and perfumery.

References-

1. The Positive Sciences of the Ancient Hindus; Brijendra Nath Seal; 4th Edition; 2016
2.Fine Arts & Technical Sciences in Ancient India with special reference to Someśvara's Mānasollāsa; Dr. Shiv Shekhar Mishra, Krishnadas Academy, Varanasi 1982
3. Mints and Minting in India; Upendra Thakur; Chowkhanba Publication; 1972
4. Science and Technology in Medieval India - A Bibliography of Source Materials in Sanskrit, Arabic and Persian by A Rahman, M A Alvi, S A Khan Ghori and K V Samba Murthy; 1982.
5. Science and Technological Exchanges between India and Soviet Central Asia (Medieval Period), ed B V Subbarayappa;1985.

Vertical: 6 Course -7- (Field project-FP/ Community Engagement program-CEP)

Course Code: CHE257: (120 Hrs, Total Credits = 04 credits)