MODERN EDUCATION SOCIETY'S

Nowrosjee Wadia College, Pune

(Autonomous)
Affiliated to Savitribai Phule Pune University

B.Sc. in Chemistry

(Faculty of Science)

New Syllabus of

F.Y. B. Sc. Chemistry

(As Per National Education Policy-2020, NEP 2.0)

To be implemented from Academic Year 2024-2025

Table of Contents

1. Abbreviations Used

- POs : Program Outcomes
- PS : Program Structure
- PSOs : Program Specific Outcomes
- COs : Course Outcomes
- TLP : Teaching-Learning Process
- AM : Assessment Method
- DSC : Discipline Specific Core
- DSE : Discipline Specific Elective
- GE : Generic Elective
- OE : Open Elective
- VSC : Vocational Skill Course
- SEC : Skill Enhancement Course
- IKS : Indian Knowledge System
- AEC : Ability Enhancement Course
- VEC : Value Education Course
- OJT : On Job Training (Internship)
- FP : Field project
- CEP : Community engagement project
- CC : Co-curricular Courses
- RM : Research Methodology
- RP : Research Project
- MJ : Major Course
- MN : Minor Course

2. Introduction to Undergraduate Degree in Chemistry

As per the recommendations of UGC and Savitribai Phule University guidelines, the undergraduate (UG) degree course in Chemistry is a 6-semester course for 3-academic years **OR** 8-semester course for 4-academic years. The Teaching-Learning Process (TLP) is student- centric. It involves theory, practical and also vocational and skill- based components. It offers flexibility in Programme structure and ensures a strong foundation and in-depth knowledge in subject. Besides the DSCs (Major Core), students have optional courses from the syllabus comprising of DSEs (Minor), VSCs, SECs, IKSs and OEs. Thus, it will facilitate the interdisciplinary as well as multidisciplinary approach within the curriculum framework. It will also allow students to have maximum flexibility in pursuing studies at UG level to the extent of having the freedom to eventually design the degree with multiple exit options. Students will have these exit options depending upon the needs and aspirations in terms of his/her career goals. This will suit the present-day needs of students in terms of securing their paths toward higher studies or employment.

3. Program Duration and Exit Options

The duration of the UG Program is 4 years or 8 semesters. Students who desire to undergo a 3-year UG Program will be allowed to exit after completion of the 3rd year. If a student wants to leave after the completion of the first or second year, the student will be given a UG Certificate or UG Diploma, respectively, provided they secure the prescribed number of credits. Students who exit with a UG certificate or UG diploma are permitted to re-enter within three years and complete the degree Program. The minimum credit to be earned by a student per semester is 18 and the maximum 26 respectively. However, students are advised to earn 22-credits per semester. This provision is meant to provide students the comfort of the flexibility of semester-wise academic load. However, the mandatory numbers of credits which have to be secured for the award of Undergraduate Certificate/Undergraduate Diploma/Bachelor Degree in Chemistry are listed in **Table 1**.

Table1: List of award of Undergraduate Certificate/ Undergraduate Diploma/Appropriate Bachelor's Degree in Chemistry

S. No.	Type of Award	Stage of Exit	Mandatory Credits to be Secured for the Award
1	Undergraduate Certificate in Chemistry	After successful completion of Semester First year	**44**
2	Undergraduate Diploma in Chemistry	After successful completion of Semester Second Year	**88**
3	Bachelor of Science in Chemistry	After successful completion of Third year	**132**
4	Bachelor of Science in Chemistry (Honours)	After successful completion of Semester Fourth year	**176**

4. Objectives of the Program

The UG degree in Chemistry aims to provide:

a. Comprehensive knowledge and coherent understanding of the Chemistry.

b. Knowledge and skills in Chemistry and related interdisciplinary areas thereby enhancing students' employability /entrepreneurship.

c. In-depth knowledge in Chemistry through understanding of key concepts, principles, theories and their manifestations.

d. Critical and analytical thinking, scientific reasoning, creativity, problem-solving skills, communication skills and teamwork.

e. Competence and skill in solving both theoretical and applied problems.

f. Exposure to the latest advances in Chemistry, allied disciplines and research.

g. Inculcate digital skills in Chemistry and interdisciplinary areas.

h. Moral and ethical awareness, leadership qualities, innovation, and life-long learning.

i. Multicultural and multilingual competence, inclusive spirit, and value education.

j. Responsibility for Community engagement and service.

5. Program Outcomes

PO No.	PO Statement After completing the Bachelor of Science Program, students will be able to-	Knowledge and Skill
PO-1	Gain a thorough knowledge and understanding of concepts and principles in Chemistry and other subjects.	Disciplinary knowledge
PO-2	Communicate the subject knowledge in a clear and simple manner in writing and oral.	Communication skill
PO-3	Identify the given problem and apply, theories/assumptions for solving the same related to real life situations	Critical thinking & problem solving
PO-4	Plan, execute, interpret and report the results of the experiments to investigate.	Research related skill
PO-5	Work effectively and respectfully as a team member in the classroom, laboratory and field-based situations.	Co-operation / teamwork
PO-6	Correlate the ideas, evidences and experiences to analyze and interpret the scientific information with learned scientific reasoning	Scientific reasoning
PO-7	Get sensibly aware with the subject facts that can be applied for the society.	Reflective thinking
PO-8	Apply modern library search tools to locate, retrieve, and evaluate subject-related information.	Information /digitally literacy
PO-9	Identify the subject resources required for a project and manage different projects	Self-directed learning
PO-10	Motivate and inspire other colleagues/students in the subject-related activities.	Leadership readiness / qualities
PO-11	Inculcate continuous learning habit through multiple Techniques	Lifelong readiness / qualities

6. Program Specific Outcomes

PSO No.	PSO Statement After completing the Bachelor of Science in Chemistry, students will be able to-	Knowledge and Skill
PSO-1	Demonstrate comprehensive knowledge and understanding of core principles, theories, and concepts in chemistry	Disciplinary knowledge
PSO-2	Apply critical thinking skills to analyze complex chemical phenomena, evaluate experimental data, and propose innovative solutions to theoretical and practical problems in chemistry.	Critical thinking & problem solving
PSO-3	Utilize resources such as textbooks, scientific literature, online courses, and professional networks to pursue self-directed learning and stay abreast of recent advancements in chemistry.	Self-directed learning
PSO-4	Utilize digital tools, software, and databases effectively for literature research, data analysis, simulation, and visualization in chemistry.	Digitally literacy
PSO-5	Exhibit leadership qualities and interpersonal skills essential for collaboration, teamwork, and effective communication within multidisciplinary research teams and professional environments.	Leadership
PSO-6	Demonstrate readiness for professional practice or further education in chemistry by exhibiting qualities such as adaptability, resilience, professionalism, and a commitment to lifelong learning.	Readiness/qualities

7. Structure of the Program

The detailed framework of Undergraduate Degree Program in Chemistry is provided in Table 2.

Table 2 Program Structure of undergraduate degree Program in Chemistry

Credit Framework for Under Graduate (2024-25) (3 Subjects) for Faculty of Science and Technology

First Year (Certificate)

Level	Sem	Subject-1	Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T) + 2(P)	2(T) + 2(P)	2(T) + 2(P)	2(T)	2(T/P)	2(T) (Generic)	2(T)	2	--	22
	II	2(T) + 2(P)	2(T) + 2(P)	2(T) + 2(P)	2(T/P)	2(T/P)	--	2(T)	2	2(T)	22
										Total	**44**

Exit Option: Students on exit shall be awarded Undergraduate Certificate in Chemistry after securing the requisite 44 credits after completion of Semester II, followed by an exit 4-credit core NSQF Course(s) or Internship.

Continue Option: Student will select one subject as a major and one subject as a minor. One subject will be dropped.

Second Year (Diploma)

Level	Sem	Credits Related to Major				Minor	GE/ OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/ CEP								
5.0/200	III	4(T) + 2(P)	--	2(T/P)	2(FP)	2(T) + 2(P)	2(T)	--	2(T) (Major Subject Specific)	2(T)	--	2	**22**
	IV	4(T) + 2(P)	--	2(T/P)	2(CEP)	2(T) + 2(P)	2(P)	2(T/P)	--	2(T)	--	2	**22**
												Total	**44**

Exit Option: Students on exit shall be awarded Undergraduate Diploma in Major and Minor with 88 credits and additional 4-credit core NSQF Course (s) or Internship.

Continue Option: Student will continue with major and minor.

Third Year (UG Degree)

Level	Sem	Credits Related to Major				Minor	GE/ OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/ CEP								
5.5/300	V	8(T) + 4(P)	2(T) + 2(P)	2(T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	22
	VI	8(T) + 4(P)	2(T) + 2(P)	2(T/P)	4OJT	--	--	--	--	--	--	--	22
												Total	44

Exit Option: Students on exit shall be awarded UG Degree in Major after securing the requisite 132 credits after completion of Semester VI. Or Continue with Major

Fourth Year (Honours Degree with Research)

Level	Sem	Credits Related to Major				Minor	GE/ OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/ CEP								
6.0/400	VII	6(T) + 4(P)	2(T) + 2(T/P)	--	4(RP)	4 (RM)	--	--	--	--	--	--	22
	VIII	6(T) + 4(P)	2(T) + 2(T/P)	--	8(RP)	--	--	--	--	--	--	--	22
												Total	44

Students on exit shall be awarded Bachelor of Science (Honours with Research Degree) after securing the requisite 176 credits after completion of Semester VIII.

Fourth Year (Honours Degree without Research)

Level	Sem	Credits Related to Major				Minor	GE/ OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/ CEP								
6.0/400	VII	10(T) + 4(P)	2(T) + 2(T/P)	--	--	4 (RM)	--	--	--	--	--	--	22
	VIII	10(T) + 4(P)	2(T) + 2(T/P)	--	4 (OJT)	--	--	--	--	--	--	--	22
												Total	44

Students on exit shall be awarded Bachelor of Science (Honours Degree) after securing the requisite 176 credits after completion of Semester VIII.

8. General guidelines for the selection of subjects

1. Student has to choose three subjects from the same faculty in first year and at the start of second year he/she has to opt one subject as Major subject and one (from other two subjects) as Minor subject and the last one will be dropped by the students.
2. Student cannot select a subject as major or minor other than the subjects taken in first year.
3. OE is to be chosen compulsorily from faculty other than that of the major.
4. SEC to be selected from the basket of Skill courses approved by the university.
5. VSC, FP/OJT/CEP should be related to the major subject.
6. AEC, VEC, IKS (Generic), and CC will be provided by the university separately.

9. Teaching-Learning Process

a. The courses will be taught through the traditional chalk and talk method, laboratory work, ICT enabled teaching learning tools, project work, seminars, case studies, field work, internships, hands-on training, etc.

b. Students will be engaged in various student centric activities like experiential learning, problem solving methodologies, participative learning and ICT based teaching learning process.

c. ICT tools in Basic and Advanced Chemistry software will be used to make the teaching learning process efficient and engaging.

d. Critical, analytical and problem-solving abilities will be developed through project-based learning, internships, industrial visits and hands-on training.

e. The problem-solving methodologies like quizzes, review of books and research papers, like workshops, research-based competitions will be used.

f. The vocational and skill training will be done through vocational and skill-based courses.

g. The students will be introduced to advanced laboratory instruments for hands-on training.

10. Methods of Assessment

The primary objective of assessment will be to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base, practical laboratory skills, and research. Assessment will be based on continuous evaluation methods and end of semester examination of Savitribai Phule Pune University, Pune.

Continuous Internal Evaluation:

During a semester, students' mastery of the various learning outcomes as described in the syllabus will be assessed through like Short Questions, Class Tests, Seminars, Presentations, Group Discussion, Quizzes, MCQs, Assignments, Tutorials, Project work, etc. Each theory paper and practical paper will have 15 marks for internal assessment for 2 credit courses and 30 marks for internal assessment for 4 credit courses.

End Semester University Examinations:

The end-semester university examinations will be conducted for both theory and practical courses. Besides internal assessment, both theory paper and practical paper will be of 35 marks each (2 credit course) and 70 marks (4 credit course) for end of semester

examination of the university.

Scheme of Examination:

The total marks for a 2-credits course are 50, and for a 4-credits course is 100.

Internal exams will be conducted by the college and external exams will be conducted by Savitribai Phule Pune University, Pune at the end of each semester.

Important for Practical Course:

a. It is mandatory to have a certified journal during the practical examination.
b. Use molar concentrations for volumetric/ estimation / synthesis experiment.
c. Use optimum concentrations and volumes.
d. Two burette methods should be used for volumetric analysis. (Homogeneous mixtures)
e. Use of microscale technique is recommended wherever possible

11. List of courses Chemistry Courses

A. List of Discipline Specific Core (DSC) Courses (Major Core)

I. Major Core (Semester-I) (4 Credits) (T + P)

1. CHE-101-T: Fundamentals of Chemistry-I
2. CHE-102-P: Chemistry Practical-I

II. Major Core (Semester-II) (4 Credits) (T + P)

1. CHE-151-T: Fundamentals of Chemistry-II
2. CHE-152-P: Chemistry Practical -II

B. List of Generic Elective (GE)/Open Elective (OE) Courses

I. Open Elective (Semester-I) (2 Credits) (T)

1. OE-101-CHE (A): Kitchen and Daily Life Chemistry

   OR

   OE-101-CHE (B): Chemistry for Competitive Examination - I

II. Open Elective (Semester-II) (2 Credits) (P)

1. OE-151-CHE (A): Chemistry for Competitive Examination – II

   OR

   OE-151-CHE (B): General Chemistry Practical-I

C. List of Skill Enhancement Courses (SEC)

I. Skill Enhancement Courses (Semester-I) (2 Credits) (T)

1. SEC-101-CHE: Chemistry Laboratory Skills – I

II. Skill Enhancement Courses (Semester-II) (2 Credits) (T/P)

1. SEC-151-CHE (A): Chemistry Laboratory Skills – II

   OR

   SEC-151-CHE (B): Chemistry Laboratory Skills – II (Practical)

12. Syllabus of Courses

Semester-I

CHE-101-T: Fundamentals of Chemistry-I

Course type: Major (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO1: recall the fundamental concepts of the mole concept, atomic structure, organic chemistry, catalysis, and surface chemistry.

CO2: explain the principles of chemical stoichiometry, Hund's rule, Aufbau principle and catalysis.

CO3: utilize the knowledge of the mole concept, atomic structure, factors affecting the reactivity of organic compounds, and surface chemistry.

CO4: apply the principles of the mole concept, atomic structure, organic reactivity, catalysis, and surface chemistry to solve the problems.

CO5: evaluate the solutions based on their concentration, and organic structures based on their reactivity and surface chemistry.

CO6: propose solutions to problems related to organic chemistry reactions, catalysis mechanisms, and atomic structure concepts, and apply them to real-world scenarios.

Course Content

Chapter 1: Essentials of Analytical Chemistry **[08 hours]**

what is analytical Chemistry, the analytical perspectives, Common analytical problems. Importance in various fields. Some important units of measurements-SI units, distinction between mass and weight, mole, millimole and Calculations, Solution and their concentrations-Molar, Normal and Molar concentrations, percent Concentration, part per million, part per billion, part per thousand, density and specific gravity of solutions, problems. Empirical and Molecular Formulas, Stoichiometric Calculations, Problems. Introduction to errors, limitations of analytical methods, classifications of errors, accuracy, precision, minimization of errors, significant figures and computation.

Chapter 2: Atomic Structure **[07 hours]**

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Sommerfield modification. Quantum numbers, introduction to the concept of atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals (qualitative idea). Many electron atoms and ions: Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitations. Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals. Quantum Mechanics: Wave particle duality, de Broglie hypothesis, and the uncertainty principle.

Chapter 3: Essentials of organic chemistry **[09 hours]**

Organic Compounds: Classification and Nomenclature, Structure and reactivity of organic molecules, Structural effects- Inductive Effect, Resonance Effect, Hyperconjugation Effect, Steric Effect, Hydrogen bonding and Tautomerism. Comparative study of strength of acids and bases based on Inductive and Resonance effect. HSAB principle, Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Reactive intermediates – carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Aromaticity: Huckel's rule and Benzenoids.

Chapter 4: Catalysis and Surface chemistry **[06 hours]**

Catalysis, Types of catalyst and catalysis, specificity and selectivity, mechanism of catalyzed reactions at solid surfaces (diffusion theory of catalysis). Introduction to surface Chemistry - some basic terms related to surface Chemistry adsorption, adsorption materials, factors affecting adsorption, characteristics of adsorption, types of adsorption, classification of adsorption isotherms, Langmuir adsorption isotherm, Freundlich's adsorption isotherm, application of adsorption, problems

References

1. Analytical Chemistry, G. D. Christian, P. K. Dasgupta, K. A. Schug, 7th Ed, Wily, 2004..
2. Fundamentals of Analytical Chemistry- Skoog, west, Holler, Crouch, 9th Ed. Brooks / Cole, 2014/2004.
3. Basic Concept of Analytical Chemistry- S. M. Khopkar.
4. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons, 2014.

5. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
6. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi 1988. 4. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
7. Kalsi P. S. Organic Reactions and Their Mechanisms, New Age International (P) Limited Publishers, 2001
8. J. D. Lee. Concise Inorganic Chemistry, 5th Ed. Blackwell Science
9. CNR Rao. University general Chemistry, an introduction to chemical science, Macmillan.
10. Brian W. Pfennig. Principles of Inorganic Chemistry, 2015 John Wiley & Sons.
11. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
12. Principles of Physical Chemistry by Puri, Sharma, Pathania.
13. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000
14. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
15. The Elements of Physical Chemistry by P. W. Atkins, Oxford

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CHE-102-P: Chemistry Practical -I

Course type: Major (Practical) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO-1: acquire basic knowledge of experiments of including adsorption, organic qualitative analysis, and inorganic preparations and estimations.

CO-2: utilize theoretical concepts to perform experiments, interpret data, and formulate conclusions.

CO-3: foster critical thinking abilities to assess and enhance the reliability and accuracy of experimental findings.

CO-4: report scientific findings of laboratory experiments.

CO-5: evaluate experimental outcomes to draw insightful conclusions.

CO-6: develop problem-solving skills.

Course Content

Set I: Physical and Analytical Chemistry (Any four)

1. To Investigate the Adsorption of acetic acid by activated charcoal and verify Freundlich adsorption isotherm.
2. Investigate the adsorption of oxalic acid by activated charcoal and verify Langmuir adsorption isotherm.
3. Estimation of aspirin from given tablet and find error in qualitative analysis.
4. Balancing of chemical equation using titration data between Oxalic acid and $KMnO_4$
5. Estimation of hardness of water by EDTA method.
6. Estimation of vitamin C from lemon juice by titrimetric method

Set II: Organic Chemistry

A. Organic Qualitative Analysis (Any three)

1. Determination of physical constant, functional group and elements of the organic compound (acidic, basic, phenolic or neutral compound).

B. Preparation of Organic Derivative

1. Preparation of semicarbazone derivative of aldehyde and ketone and purity by TLC

Set III: Inorganic Chemistry

a. Inorganic Preparations (Any three)

2. Synthesis of potash alum from aluminium metal (scrap Aluminium metal) and qualitative test for anion and cation.
3. Synthesis of Mohr's Salt $[(FeSO_4)\ (NH_4)_2SO_4]\bullet 6H_2O$ and qualitative test for anion and cation.
4. Synthesis of $FeSO_4\bullet 7H_2O$ and qualitative test for anion and cation.
5. Preparation of Dark red inorganic pigment: Cu_2O and qualitative test for cation.

b. Estimation of Purity of salt (Compulsory)

Determination of purity of any one of the synthesized salt by volumetric method.

For Self-Learning and Internal Evaluation:

1. Safety symbol on labels of pack of chemicals and its meaning
2. Precautions in handling of hazardous substances.
3. Toxicity of the compounds used in chemistry laboratory and classification of toxicity.
4. Preparation of solutions of different strengths (Percentage solutions, Molar, molal and normal solutions)

References:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. R.K. Gupta and O.P. Gupta, Practical Chemistry.
7. Daniel C. Harris, Quantitative Chemical Analysis.
8. O.P. Tandon, Practical Chemistry.
9. N.K. Verma and S.C. Kheterpal, Comprehensive Practical Chemistry
10. K.C. Jain, Advanced Practical Chemistry.

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OE-101-CHE (A): Kitchen and Daily Life Chemistry

Course type: Open Elective (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO-1: understand the chemical composition of food, including macromolecules, nutrients, and additives, and their significance in cooking, nutrition, and medical applications

CO-2: apply knowledge of macromolecules, cooking chemistry, and food additives to analyze and optimize cooking processes, ensuring the preservation of nutritional value and sensory quality in prepared foods.

CO-3: evaluate the classification and sources of nutrients in food, considering macronutrients, micronutrients, and additives, to make informed dietary choices that support overall health and well-being.

CO-4: critically analyze the role of food additives in food preservation and flavor enhancement, considering their chemical composition and potential impacts on human health and food quality.

CO-5: explore the application of chemistry principles in Kitchen and Daily Life Chemistry.

CO-6: apply the knowledge of Kitchen and Daily Life Chemistry for daily life practices

Course content

Chapter 1: Macromolecules in Food **[05 hours]**

Understanding the role of carbohydrates, proteins, and lipids in food systems, Chemical structures and functions of macromolecules in cooking and nutrition, Impact of macromolecules on the taste, texture, and nutritional value of food.

Chapter 2: Chemistry of Cooking **[04 hours]**

Physical and Chemical changes, Stability of nutrients during cooking. Microwave cooking, Food sterilization, Chemistry of spices and herbs, Safety protocols and best practices in kitchen chemistry.

Chapter 3: Classification and sources of nutrients **[05 hours]**

a) Carbohydrate-rich foods: Wheat, rice, potato, sugar, etc. b) Protein-rich foods: Egg, milk, meat, fish, pulses, etc. c) Fat-rich foods: Oil, ghee, butter, groundnut, etc. d) Vitamins rich foods: Fruits, green leafy vegetables e) vitamins and minerals

Chapter 4: Food additives [06 hours]

Adulterants, and contaminants- Food preservatives like benzoates, propionates, sorbates, disulphites. Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose, and sodium cyclamate.

Flavors: Vanillin, alkyl esters (fruit flavors), and monosodium glutamate. Artificial food colorants: Coal tar dyes and non-permitted colors and metallic salts. Analysis of pesticide residues in food.

Safety considerations and regulatory aspects of food additives in food production.

Chapter 5: Chemistry in the Medicine [10 hours]

Introduction to Medicines, Definition of a Medicinal drug, Requirements of an ideal drug, Nomenclature of drugs: Generic name, Brand name, Systematic name

Difference between prescription and over the counter medicines, Identification of expiry and manufacturing date, Storing medicines and its importance & disposal of medicines.

Simple Concept of antacids, antihistamines, antiseptic ointment, topical ointment, antifungal, anti-sickness, antipyretics, antihypertensive, antidiabetics Concept of sedation, hypnotics and anesthesia

References

1. The Science of Cooking: Understanding the Biology and Chemistry behind Food and Cooking; Joseph J. Provost, Keri L. Colabroy, Brenda S. Kelly, Mark A. Wallert; ISBN: 978-1-118-67420-8.
2. Dairy Chemistry and Animal Nutrition – M.M. Roy.
3. Fundamentals of Dairy Chemistry -B.H. Webb, A.H. Hooson, J.A. Alford, CBB Publishers
4. Milk and Milk Products-C.H. Eckles, H. Macy, Tata McGraw Hill Publishing Company
5. Essential Guide To Food Additives by Victoria Emerton and Eugenia Choi https://books.rsc.org/books/edited-volume/21/Essential-Guide-to-Food-Additives
6. Food Additives Data Book by Jim Smith and Lily Hong-Shum.
7. Food Additives by A. Larry Branen, P. Michael Davidson, Seppo Salminen and John H. Thorngate III
8. Food and Nutrition Handbook for Extension Workers by Ministry of Agriculture, Animal Industry and Fisheries.
9. Textbook on Nutrition & Dietetics for Post Basic BSc Nursing Students by I. Clement.

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OR

OE-101-CHE (B): Chemistry for Competitive Examination – I

Course type: Open Elective (Theory) **No. of Credits: 2**

Course Outcomes

CO-1: Define the terms matter, atom, chemical bond, oxidation, reduction, acid, base, catalysis, solution, fuel, element, metal, metallurgy, isomerism, polymer, rubber, explosives, drugs, oil mole, millimole, waxes, etc.

CO-2: Describe structure of atom, chemical bonding, Chemical symbol, formula and equation, Periodic classification of elements, the analytical perspectives.

CO-3: Explain the terms alcohols, Petroleum, Soap and detergents, Oils and fats, Waxes, . Polymers, Rubbers, Explosives, Drugs & chemicals, Fuels, and Radioactivity.

CO-4: Distinguish between the mass and weight, mole and millimole, soap and detergents, acid and bases, oxidation and reduction, etc.

CO-5: Classify chemical bond, polymers, explosives, rubber, waxes, soap and detergents.

CO-6: Give uses of polymers, explosives, rubber, waxes, soap and detergents, petroleum, etc.

Course Content

Chapter-1: Introduction to Physical Chemistry [08 hours]

1. Atom and its structure: Introduction, constituents of an atom, Thomson model, Rutherford model, Bohrs model, Quantum model, Atomic number, atomic mass, Isotope, Isobar, Quantum numbers.
2. Chemical bonding: Introduction, Valency, Types of bonding, Dipole moment, Fajan rule, VSEPR, VBT, MOT, Hydrogen bond.
3. Concept of matter: Introduction, Classification of matter, Gas laws, change of states, latent heat, Specific heat capacity, Temperature.

Reference: II Page no 2 to 30

Chapter-2: Introduction to Inorganic Chemistry [07 hours]

1. Periodic Table: Introduction, Dobereiner triads, Newlands octaves, Mendeleeves periodic law, modern periodic table, Important elements and its properties and function,Perodic properties of element.
2. Classification of Elements: Introduction, Metals, non-metal, Metalloids and its properties, uses, Important Reactions with metals.

Reference: II Page no 42 to 55

Chapter-3: Introduction to Organic Chemistry [10 hours]

1 World of Carbon: Introduction, Carbon, Hydrocarbon and its types, Structure of hydrocarbon, Isomerism, Nomenclature, Catenation , Allotrops of carbon ,Chemical reactions of carbon compounds, Coal, Petrolium and its purification, some intresting facts.

2. Chemical Reactions: Introduction, Important terminology, rules for writing chemical reaction, Types of chemical reactions, Oxidation and reduction, order of reaction, Important points. **Reference: II Page no 60 to 86**

Chapter-4: Miscellaneous Chemistry [05hours]

1. Polymer: Properties, Types, applications. Rubbers: Properties, Types, uses.
2. Explosives: TNG, TNT, TNB, TNP, RDX
3. Drugs and chemicals: Introduction, Basic terms used in drugs, Classification, Antibiotics, antipyretics, analgesics, antiseptics, Transquilizers, Disinfectant, Antifertility drugs, antacid, pesticide, insecticide, fungicide, insecticide, herbicide

Reference: I Relevant pages

Reference Book:

1. **Lucent's** General Science by Sunil Kumar Singh, Lucent Publication
2. **General Science book** Part-II for competitive examination by Dr.Sachin Bhaske

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SEC-101-CHE: Chemistry Laboratory Skills – I

Course type: Skill enhancement (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO1: know the Lab Safety

CO2: demonstrate laboratory apparatus, equipments, reagents and laboratory techniques.

CO3: prepare reagents and solutions of various concentrations.

CO4: explain standard safety guidelines, apparatus, reagents, solvents, solutions and laboratory techniques.

CO5: prepare solutions of various concentrations

CO6: design safe methods for laboratory techniques.

Course Content

Chapter 1: Introduction to Chemical and Laboratory Safety [04 hours]

Introduction to Good lab practice (GLP) History, Scope, fundamental Points of GLP, Four Principles of safety-RAMP, The Student Safety Ethics, Safety rules, Role as a Student, analysis of Lab incidents, Standard Operating Procedures (SOP) in the laboratory.

Chapter 2: Understanding Laboratory Hazards[04 hours]

Potential pathways of exposure and blocking these pathways to prevent exposure, Hazard recognition through the basics of understanding label, signs, symbols, terms, and othersources of information, Safe handling and interpreting the material safety data sheet(MSDS), overview of GHS Safety Data Sheets and GHS labelling.

Chapter 3: Laboratory Hazards and Responses [12 hours]

Chemical Hazards: corrosive acids, bases, gases, oxidizers, flammables, fire triangle, water reactive compounds, pyrophoric chemicals and reactions, peroxides, cryogens.

Radiation Hazards: ionizing, nonionizing radiations and electric and magnetic field.

Biological Hazards: hazards of biological agents and some general approaches to prevent exposures.

Electrical Hazards: electric shock and burns from contact with live parts, explosion caused by unsuitable electrical apparatus, measures to avoid electrical hazard.

Introduction to Toxicology: Basic principles of toxicology, Factors Influence Toxicity,

Acute and Chronic Toxicity, Mercury toxicity, Carcinogens, Mutagens.

Fire-fighting in Chemical Lab: Fire Safety in Chemical Lab, Classification and Use of Fire Extinguishers, Introduction of Fire-fighting Equipment and Fire Safety Symbols)

Responses: chemical spills (acids, bases and other chemicals) and fire, classes of fires and types of fire extinguishers. First aid in chemical lab, emergency safety equipment.

Chapter 4: Handling Chemicals and Minimizing Hazards in Laboratory [08 hours]

Introduction to handling hazardous chemical waste, storing flammable and corrosive liquids, maintaining a safe and secure laboratory, managing chemicals in the laboratory. Safety measures for common laboratory operations. Managing risk- decision about safety, eye and face, skin protection- clothes, gloves and tools, chemical hoods, contamination and ventilation, safety measures for common laboratory operations, radiation, laser and biological safety cabinets. Lab waste management.

Chapter 5: Case Studies of Chemical and Laboratory Accidents [02 hours]

Introduction to chemical and Laboratory Accidents, The Bhopal gas disaster

References

1. Laboratory safety for Chemistry students, second edition, Robert H. Hill, Jr.David C.Finster, John Wiley & Sons.
2. Handbook of Good laboratory practice (GLP),UNDP/World Bank/WHO Special Program for Research and Training in Tropical Diseases (TDR) https://fctc.who.int/publications/i/item/handbook-good-laboratory-practice-%28- glp%29
3. Solid Waste Management, Principles and Practice, Ramesha Chandrappa, DigantaBhusan Das, Springer.
4. Production-Integrated Environmental Protection and Waste Management in the Chemical Industry, Claus Christ, WILEY-VCH.
5. Laboratory safety Handbook, FENS Laboratory safety Team, 1st edition 2016. https://fens.sabanciuniv.edu/sites/fens.sabanciuniv.edu/files/2021-08/labsafety_web.pdf
6. Fundamentals of Industrial Safety and Health Dr. K.U. Mistry, Siddharth Prakashan.
7. Hazardous waste management rules-2016, 1st edition, Ministry of environment, forest& climate change, govt. of India

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Semester-II

CHE-151-T: Fundamentals of Chemistry-II

Course type: Major (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO1: recall and explain the fundamental principles and concepts from Photochemistry, Chemical Kinetics, Periodicity, Stereochemistry, and Chemical Bonding.

CO2: identify experimental key concepts involved in Photochemistry, Chemical Kinetics, Periodicity, Stereochemistry, and Chemical Bonding.

CO3: draw conclusions about reaction mechanisms, kinetics, periodic trends, stereochemical relationships, and bonding properties.

CO4: apply the principles of Photochemistry, Chemical Kinetics, Periodicity, Stereochemistry, and Chemical Bonding to solve complex problems and scenarios.

CO5: evaluate the significance of photochemical reactions, kinetic processes, periodicity, bonding theories like VBT and MOT and stereochemical structures.

CO6: propose solutions, and contribute to the advancement of scientific knowledge applications.

Course Content

Chapter 1: Photochemistry [06 hours]

Introduction, Difference between thermal and photochemical processes. b. Laws of photochemistry i) Grothus - Draper law ii) Stark-Einstein law. c. Quantum yield, Reasons for high and low quantum yield. Factors affecting Quantum yield, Experimental method for the determination of quantum yield & Problems. d. Fluorescence, Phosphorescence, Chemiluminescence.

Chapter 2: Chemical Kinetics [04 hours]

Recapitulation: Rate of a reaction (Average and instantaneous), order and Molecularity of a reaction, rate law and specific rate constant, First order and Pseudo molecular reaction (Without derivation).

Second order reaction expression, Numerical based on rate of reaction, half-life period and rate constant of First order reaction only.

Chapter 3: Periodicity [07 hours]

The long form of periodic table. s, p, d, f block elements, Detailed discussion of the following properties of the elements, with reference to s & p-blocks. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic radii. (d) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (e) Electron gain enthalpy; trends of electron gain enthalpy. (f) Electronegativity, Pauling's/ Mullikan's electronegativity scales. (g) Oxidation states of elements

Chapter 4: Stereochemistry [09 hours]

Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diasteromers, threo and erythro diastereomers, meso compounds, Racemic mixture and resolution, Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature.

Chapter 5: Chemical bonding [04 hours]

Atomic orbitals, multiple bonding (σ, π and delta bond approach) and bond lengths, the Valence Bond Theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent rule, Valence Shell Electron Pair Repulsion theory (VSEPR), shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_5, SF_6, SF_4, ClF_3, I_3^-, and H_3O^+.

References

1. Essential of Physical Chemistry, Bahl and Tuli (S. Chand).
2. Principles of Physical Chemistry by Puri, Sharma, Pathania.
3. Physical Chemistry, Singh, N.B., et al. Volume 2, New Age International Ltd, 2000
4. Physical Chemistry by, R. A. Alberty, Wiley Eastern Ltd.
5. The Elements of Physical Chemistry by P. W. Atkins, Oxford
6. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
7. Stereochemistry of Organic Compounds: Principles and Applications Paperback – 7 January 2018 by D. Nasipuri
8. Stereochemistry : conformation and mechanism by Kalsi, P. S
9. Stereochemistry of Organic Compounds by VK Ahluwalia
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

11. J. D. Lee. Concise Inorganic Chemistry, 5th Ed. Blackwell Science

12. CNR Rao. University general Chemistry, an introduction to chemical science, Macmillan.

13. Brian W. Pfennig. Principles of Inorganic Chemistry, 2015 John Wiley & Sons.

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CHE-152-P: Chemistry Practical-II

Course type: Major (Practical) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO-1: learn vital lab techniques: colorimetry, kinetics, organic purification, investigative inorganic experiments, and Avogadro applications.

CO-2: apply theoretical principles to design and conduct experiments, analyze data, and draw conclusions.

CO-3: cultivate critical thinking skills to ensure the reliability and accuracy of experimental results.

CO-4: communicate scientific findings through laboratory reports, utilizing proper scientific formatting, terminology, and data analysis techniques.

CO-5: evaluate experimental outcomes to draw insightful conclusions.

CO-6: develop problem-solving skills.

Course Content

Set I: Physical and Analytical Chemistry (Any four)

1. Determination of unknown concentration of $KMnO_4$ by Colorimetry.
2. Estimation of Cu^{++} ion by using EDTA Calorimetrically.
3. Determination of Heat of Neutralization of Strong Acid & Strong Base.
4. Study the kinetics of acid hydrolysis of methyl acetate with hydrochloric acid.
5. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate
6. Study of kinetics of decomposition of H_2O_2 (Clock Reaction)

Set II: Organic Chemistry

A. Organic Purification Techniques (Any two)

1. Purification of organic compounds by-

i) Crystallization (from water and alcohol)

ii) Sublimation

iii) Simple distillation

iv) Steam distillation

C. Analysis of Organic Compound (Any two)

1. Detection of elements (N, S, Cl, Br, I) in the organic compounds

Set III: Inorganic Chemistry

A. Investigative Experiments in Inorganic Chemistry (Any two)

1. Study stoichiometry of reaction between $KMnO_4$ and $FeSO_4$ by titration method hence determination of number of electrons involved in the reaction and equivalent weight of oxidizing agent - $KMnO_4$.
2. Determination of dissociable H^+ ions (basicity) of boric acid hence determination of its equivalent weigh by acid base titration. Explain observed basicity of the boric acid.
3. Estimation of number of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of caustic soda from soap by titrimetric method

B. Table work (Compulsory)

1. Polar plots of s and p orbitals

C. Chemistry with Computers (Any one)

2. Study of molecular properties of some molecules using open access computational Chemistry package Avogadro and give the explanations for observed properties.
3. Draw the structure of using Avogadro. Record their bond length and dipole moment of these molecules and explain observed trend in periodicity of these two properties of in halide group elements.
4. Draw the structure of H_2O, H_2S, H_2Se and H_2Te molecules using Avogadro. Optimize structure. Record their bond length, bond Angel and dipole moment of these molecules. Explain observed trend in periodicity of these three properties of in halide group elements.
5. Draw the structure of CH_4, NH_3, H_2O, molecules using Avogadro. Optimize structure. Record their bond length, bond Angle and dipole moment of these molecules. Explain observed bond angles.

References:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. R.K. Gupta and O.P. Gupta, Practical Chemistry.

7. Daniel C. Harris, Quantitative Chemical Analysis.
8. O.P. Tandon, Practical Chemistry.
9. N.K. Verma and S.C. Kheterpal, Comprehensive Practical Chemistry
10. K.C. Jain, Advanced Practical Chemistry.
11. https://avogadro.cc/

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OE-151-CHE (A): Chemistry for Competitive Examination – II

Course type: Open Elective (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO-1: Define the terms matter, atom, chemical bond, valency, dipole moment, hydrogen bond, oxidation, reduction, acid, base, catalysis, solution, element, metal, isomerism, polymer, rubber, explosives, drugs, etc.

CO-2: Describe structure of atom, chemical bonding, Chemical symbol, formula and equation, Periodic classification of elements.

CO-3: Explain the terms catenation, Petroleum, Allotrops, Polymers, Rubbers, Explosives, Drugs & chemicals, latent heat, specific heat capacity

CO-4: Distinguish between the metal and nonmetal, VBT and MOT, acid and bases, oxidation and reduction, etc.

CO-5: Classify chemical bond, polymers, explosives, rubber, Matter, elements, Drugs.

CO-6: Give uses of polymers, explosives, rubber, petroleum, Drugs and chemical, pesticide, insecticide, fungicide, herbicide, etc.

Course Content

Chapter-1: Introduction to Physical Chemistry [08 hours]

a. Chemical classification of matter: Introduction, Elements, Compounds, Molecules and compounds, Molecular mass and Mole concept, Formula mass, Emprical and Molecular formula, Mole fraction, Mixture, Homogeneous and Heterogeneous mixture, Important points. **Reference: II Page no 34 to 41**

b. Thermodynamics: Introduction, Heat and Temperature, Specific heat, Effects of heat, Heat transfer, Laws of Thermodynamics, Entropy.

Reference: II Page no 88 to 92

Chapter-2: Introduction to Inorganic Chemistry [07 hours]

a. Minearals and ores: Introduction, Minerals, Ores, Extraction of ore, Roasting, Calcination, Galvanizing, Tinning, Electroplating, Anodising, Alloying, Purification methods of metal, soil and its Types. **Reference: II Page no 56 to 59**

b. Acid, Base and Salt: Introduction, Acid and its properties, Effect of indicator on acid and

bases, Bases and its properties, The pH Scale, Salts, Different definitions of Acid and Bases, Classification of Acid and Bases, Buffer, Important Point. **Reference: II Page no 72 to 79**

Chapter-3: Introduction to Organic Chemistry **[05 hours]**

a. Alcohol,Phenol and Ether its Structure, properties and applications .

b. Aldehyde, Ketones its Structure, properties and applications

c. Carboxylic acids its Structure, properties and applications.

Reference: I & II Relevant pages

Chapter-4: Miscellaneous Chemistry **[10 hours]**

a. Fertilizers: Introduction, Classification, Uses

b. Dyes: Introduction, Different classes, its uses

c. Types of glasses,

d. Soap and Detergent,

e. Food preservative like, benzoates, propionate, sorbates.

f. Artificial sweetners: aspartame, saccharin, dulcin, sucralose, Flavers like vanillin, monosodium glutamate.

g. Artificial food colourant.

h. Environmental Chemistry: Hydrologic cycle, Air Pollution, Water pollution.

Reference: I & II Relevant pages

Reference Book:

1. Lucent's General Science by Sunil Kumar Singh, Lucent Publication.

2. General Science Book Part-II for competitive examination by Dr.Sachin Bhaske

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OR

OE-151-CHE (B): General Chemistry Practical-I

Course type: Open Elective (Practical) **No. of Credits: 2**

Course Outcomes

CO-1: Proficiency in conducting various chemical tests to determine the quality and authenticity of food items commonly found in the kitchen, such as fats, oils, and dairy products.

CO-2: Ability to utilize chemical indicators and instruments effectively for assessing parameters like acidity, pH, and moisture content in food samples, enhancing understanding of their chemical composition and stability.

CO-3: Skill development in detecting common food adulterants and contaminants, ensuring the safety and integrity of food products consumed in daily life.

CO-4: Understanding the chemical processes involved in food preparation and preservation, demonstrated through experiments such as soap/detergent preparation and CO_2 production in baking soda reactions.

CO-5: Application of laboratory techniques for identifying and isolating specific food components, such as starch in various food products, aiding in quality control and nutritional analysis.

CO-6: Critical analysis of experimental results and interpretation of findings in the context of food chemistry principles, fostering informed decision-making regarding food selection, consumption, and storage practices.

Course content

Any 12 experiments from the given list-

1. Determination of Acid value in Fats and oils
2. Determination of Iodine value in Fats and oils
3. Detection of Urea in Milk
4. Detection of Starch in Milk
5. Detection of Sodium Chloride in Milk
6. Detection of Nitrate in Milk
7. Preparation of Soaps/Detergents.
8. Determination of moisture in a given food sample
9. Determination of pH of a given sample using universal indicator and pH meter.

10. Determination of acidity of given food sample/beverage.
11. Identification and isolation of starch in given food sample
12. Effect of baking soda on CO_2 production
13. Detection of preservatives in milk a) formaldehyde b) boric acid
14. Determination of pH of Buffalo and Cow milk.
15. Detection of hydrogen peroxide from milk samples
16. Detection of adulterants in ice cream.
17. Detection of starch in different sweet products (eg. Khoya / ice-cream)
18. Detection of coloured adulterants in red chili powder.
19. Detection of sugar /dextrose from Honey
20. Detection of adulterants in tea powder
21. Detection of adulterants in oil /vanspati ghee 1
22. Detection of sodium bicarbonate from different food samples (cooked food)
23. Identification of adulterants used in fruits and vegetables.

Note: Visit to hospital/slide show on various nutritional deficiency disorders and prepare report accordingly

References

1. Visit- https://www.fssai.gov.in/ Food Safety and Standards Authority of India (FSSAI) – For Manual of Methods of Analysis
2. Limerick, Thomond College. Bailin, S. (2002). Critical thinking and science education. Science & Education, 11(4), 361-375.
3. 'Chemistry In Daily Life' by Kirpal Singh [3rd Edition], PHI Learning
4. The Food Chemistry Laboratory: A Manual for Experimental Foods, Dietetics, and Food Scientists by Connie M. Weaver and James R. Daniel, 2nd edition, CRC Press
5. Manual Of Methods Of Analysis Of Foods (Milk And Milk Products)- Directorate General Of Health Services Ministry Of Health And Family Welfare Government Of India New Delhi, 2005
6. Food safety and standard authority of India (FSSAI) New Delhi
7. Manual of methods of analysis of foods: Milk and milk products D.G.H. Services (Ed.) 2005
8. Detection of adulterants in milk, A laboratory manual In N.D.R. Institute (Ed.) Karnal Haryana India 2012
9. Manual of methods of analysis of foods honey& other bee hive products (FSSAI)

10. Manual of methods of analysis of foods food safety and standards authority of India ministry of health and family welfare government of India new Delhi 2015
11. Food Adulteration Testing Manual (14th Revised Edition) –Consumer Guidance Society of India (CGSI) Mumbai-2019

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SEC-151 CHE (A): Chemistry Laboratory Skills-II

Course type: Skill Enhancement (Theory) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO1: know the Lab Safety

CO2: demonstrate laboratory apparatus, equipments, reagents and laboratory techniques.

CO3: prepare reagents and solutions of various concentrations.

CO4: explain standard safety guidelines, apparatus, reagents, solvents, solutions and laboratory techniques.

CO5: justify the filing and record systems.

CO6: create a standard operating procedure for working in a laboratory.

Course Content

Chapter 1: Laboratory Reagents and Solvents [08 Hours]

Reagents: Classification of reagents according to their action; (i) acids (ii) bases (iii) salts (iv) complexing agents (v) oxidizing and reducing agents (vi) precipitating agents (vii) chelating agents (viii) Drying Agents. Each type to be explained with at least one suitable example. Primary and secondary standards: Definition, characteristics, uses examples for different types ofreactions.

Solvents: Solute, Solvent & Solution, classification of solvents (i) Protic and aprotic (ii) Acidic, basic amphiprotic and neutral (iii) Aqueous and non-aqueous (iv) Polar andnonpolar. Each type is to be explained with at least one example.

Chapter 2: Preparation and Standardization of Solutions [02 hours]

Recapitulation: Concepts of molarity, molality, and normality

Preparation of standard solutions, Techniques for dilution and standardization of solutions

Chapter 3: Common Laboratory Techniques [06 Hours]

Refluxing: Apparatus with interchangeable ground glass joints (Quick fit),

Filtration: Techniques and filter media, filter paper, simple filtration,

Recrystallization: Choice of solvent and precautions with flammable solvents,

Distillation: recovery of solvents through partial distillation, distillation under reduced pressure, and Determination of Boiling Point

Extraction: Use of Separating funnel and Soxhlet Extractor

Chapter 4: Instruments, Equipment and apparatus handling [08 Hours]

Heating Devices and thermal safety, Fuming hood, Ovens, Hot plates, heating mantles, Oil, salt and sand baths, High pressure vessels, vacuum pumps, rotary evaporators, refrigerators and freezers, calibration of pH meter, Digital Balance, Magnetic Stirrer, Desiccator, Kipp's apparatus, Mortar and pestle, Ostwald's Viscometer, volumetric flask, TLC Cabinet (UV Chamber), Centrifuges, volumetric equipmentd (volumetric flasks, graduated cylinders, pipettes, burettes) and their calibration and accurate measurement techniques

Chapter 5: Stock and Inventory Control [02 Hours]

Arranging stock, locating and referencing, shelf arrangement of stock, order books, inventory.

Chapter 6: Files and Records [04 Hours]

Filing Systems- Classification of files, filing methods, filing system for equipment's and chemicals, filing of printed and written material, preparation of lab manuals.

Records system: Stock records, recording stock (used and misused), record of use of listed poisons, record of use of alcohol, record of breakages, information about equipment serial numbers, record maintenance, miscellaneous records.

References

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by GH Jeffery and others) 5th Ed. The English Language Book Society of Longman
2. Willard, Hobert H. et. al: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. New York- John Willy, 2004.
4. Harris, Daniel C,Quantitative Chemical Analysis, 3 rd Edition, W.H. Freeman and Company, New York, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry New Age, International Publisher, 2009.
6. Koogs, West and Holler, Fundamentals of Analytical Chemistry, 6th Edition, Sauders College Publishing, New York. 1991.

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OR

SEC-151 CHE (B): Chemistry Laboratory Skills – II

(Practical)

Course type: Skill Enhancement (Practical) **No. of Credits: 2**

Course Outcomes

After the completion of this course, student will be able to-

CO-1: Learn the Chemistry laboratory techniques.

CO-2: Know the safe manipulation of various glassware, apparatus and equipments.

CO-3: explain safe and proper management of chemicals and laboratory apparatus/equipment.

CO-4: formulate operational guidelines for chemical and instruments methods.

CO-5: Evaluate the glassware, apparatus, and equipment's on the basis of need of the experiments.

CO-6: Create a report/guideline on Chemistry Laboratory Techniques.

Course content

Any 12 experiments from the given list-

1. a) Identify and list the Incompatible Chemicals from a given set of chemicals availablein the laboratory, b) Carry out preparation of the indicative MSDS (Material Safety Data Sheet) of given set of chemicals as per Standard MSDS format c) Carry out Classification and labeling of the given set of chemicals based upon the Globally Harmonized System.
2. Demonstration and use of fire extinguisher, fuming hood and First aid box (any two).
3. Conduct an investigation into the proper procedures for managing, operating, and utilizing the standard laboratory equipment.
4. Perform experiments with different laboratory equipment made from various materials, including Pyrex Glass (borosilicate Glass), Fused Silica (Corning Vycor Glass), Porcelain, Plastic, and Metal, based on the materials they are composed of.
5. Cork boring experiment
6. Comprehending the procedure for cleaning, drying, and polishing glassware equipment.
7. i. Perform the calibration of volumetric and graduated glassware equipment while

providing an explanation of temperature standards.

ii. Perform thermometer calibration.

8. i. Carry out exploration and investigations of working protocol for various heating equipment in laboratory: Burners, Hot Plates, Electrical Heating Mantles, Electric Oven, Microwave Oven, Muffle Furnace, Infrared lamps, Crucible and Beaker Tongs and Emersion heaters.

   ii. Carry out exploration and investigations of working protocol for various Stirring apparatus in laboratory: Stirring rods; Policeman, Boiling rods, Use of Mechanical agitation-Magnetic Stirrer and Mechanical Shaker.

   iii. Carefully analyze the Glass, Cork and Rubber Stoppers and investigate their preparation and appropriate applications.

9. i. Conduct thorough examinations of Heating and Cooling Baths to establish their operational limits and operational procedures.

   ii. Investigate and distinguish various types of water suitable for laboratory applications, including Distilled (Grade I to III), De-ionized, and tap water. Perform conductance measurements and other analytical assessments to distinguish between them.

10. i. Distinguish between different types of filter paper and investigate their uses.

    ii. Creating corrugated filter paper and its benefits.

    iii. Categorizing chemicals as either analytical reagent (AR) or general reagent (GR) grade.

11. i. Understanding the proper handling and operation of Analytical balances: Mass and Weight, Dual-Pan Balance and Electronic Balance.

    ii. Performing the calibration of weighing balances and ensuring precision in measurements.

12. i. Utilization of a melting point instrument for the experimental determination of the melting points through diverse techniques.

    ii. Experimental determination of the boiling point using various methods.

13. To purify given organic solvents.

14. i. Hand on training for working with typical assemblies of apparatus for distillation and refluxing.

    ii. Assessment of Fire hazards attending the distillation of inflammable solvents

15. i. Purification of given solid organic compounds by crystallization method.

    ii. Recrystallization of given non-volatile organic solids and outline the Difficulties encountered in recrystallization process.

16. Removal of traces of colouring matter and use of decolourising carbon.
17. i. Carry out exploration and investigations of working and working protocol for Filtration Apparatus: Filtration with suction.
    ii. Explore and imbibe knowledge about types of Vacuum Pump; Water and Oil Pump and their applications.
18. Investigate Conventions for Drying of the recrystallized material.
19. i. Introduction to Gas absorption traps and their importance.
    ii. Recrystallization in an atmosphere of inert gas
20. i. Performing Evaporation of the solvent in the laboratory.
    ii. Preparation of anhydrous liquids or solutions of organic compounds in organic solvents.
21. i. Various procedures for the precipitation and washing of the precipitates.
    ii. Application of various methods and instruments for drying of solid organic compounds.
22. i. Incineration of Filter paper with precipitate.
    ii. Differentiate between various types of centrifugation methods, principle, uses and application of centrifugation method
23. Comprehensive knowledge and preparation of reagents for chemical laboratory purposes.
24. Examine approaches for creating and preserving standard solution preparations.

Compulsory Activity: Visit to any industry or Chemical supplier laboratory/shop or Agriculture field (pesticide survey) or Milk industry or chemical industry. It is mandatory to have a hard copy of a report on compulsory activity along with a certified journal during the practical examination.

References

1. Skoog D.A., West D.M., Holler F.J., Stanley R.C., Fundamentals of analytical Chemistry, 9th Edition, Cengage Learning.
2. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis, 6th Edition, Prentice Hall.
3. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
4. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), Experiments in Physical

Chemistry, 8th Edition, McGraw-Hill, New York.

5. Vogel's Textbook of Practical Organic Chemistry
6. Vogel - A Text-Book of Quantitative Inorganic Analysis
7. https://iupac.org/
8. https://edu.rsc.org/resources/practical/experiments