Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

National Education Policy (NEP)
Choice Based Credit System (CBCS)

Programme Framework

B. Sc. - I (Chemistry)

Implemented from

Academic Year 2024-25

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar

(Autonomous)

Board of Studies in Chemistry

Sr. No.	Name	Designation
1.	Prof. Dr. D. R. Thube	Chairman
2.	Asso. Prof. P. S. Mutkule	Member
3.	Asso. Prof. S. B. Dare	Member
4.	Dr. S. J. Takate	Member
5.	Asst. Prof. P. B. Gaikwad	Member
6.	Asst. Prof. A. V. Karande	Member
7.	Dr. N. R. Dhatrak (SPPU)	Vice-Chancellor Nominee
8.	Dr. B. B. Shingate (BAMU, Aurangabad)	Academic Council Nominee
9.	Dr. S. S. Kolekar (Shivaji University,Kolhapur)	Academic Council Nominee
10.	Dr. P. C. Mhaske (S. P. College, Pune)	Alumni
11.	Dr. D. N. Sawant (NCL, Pune)	Industry Expert

1. Prologue/ Introduction of the programme:

Academics and research in India are a priority which depends upon the quality of education. Quality higher education include innovations that can be useful for efficient governance of higher education institutions, systems and society at large. Fundamental approach to learning outcome-based curriculum emphasizes upon demonstration of understanding, knowledge, skills, attitudes and values in particular programme of study. This approach is intended to follow flexibility and innovation in design of the programme, its assessment and expect graduate attributes demonstrating the level of learning outcome. It is expected to provide effective teaching – learning strategies including periodic review of the programme and its academic standard. The learning outcome-based curriculum for B.Sc. degree in Chemistry is designed to address the needs of the students with chemistry as the core subject of study. The curriculum is expected to assist in the maintenance of the standard of chemistry degrees/programmes and periodic programme review within a broad framework of agreed/expected graduate attributes qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework is intended to allow flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students learning levels.

This curriculum for the bachelor-level program in Chemistry is developed keeping in view of the student centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. To avoid rote-learning approach and foster imagination, the curriculum is more leaned towards self-discovery of concepts. The curriculum focuses on pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field works. The platform aims at equipping the graduates with necessary skills for Chemistry-related careers, careers with general graduate-level aptitude and for higher education in Chemistry and allied subjects. Augmented in this curriculum are graduate attributes including critical thinking, scientific reasoning, moral ethical reasoning, qualification descriptors that are specific outcomes pertinent to the discipline of chemistry, learning outcomes for individual courses, pedagogical methods and assessment methods. While designing syllabus, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the graduates. In line with recent trends in education section, this syllabus fosters implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e- learning platforms. The framework is designed such a way to enable the learners implementing the concepts to address the real-world problems. The curriculum focuses on issues pertinent to India and also of the west; for example, green chemistry and biomaterials etc. Curriculum are holistic and aim to mould responsible Indian citizen to have reflective thinking, scientific temper, and digital literacy in order to acquire requisite skill to be self-employed entrepreneurial.

2. Programme outcomes for B.Sc. Chemistry

Students enrolled in the program complete a curriculum that exposes and trains students in a full range of essential skills and abilities. They will have the opportunity to master the following objectives.

Programme Outcomes

- To understand the basic facts and concepts in Chemistry
- To understand the importance of Chemistry in daily life.
- To develop a better understanding and reasoning of facts.
- Gain the knowledge of Chemistry through theory and practicals.
- To skill-up for basic analytical tools.
- To skill-up for various laboratory techniques used in pharmaceutical laboratories and chemical industries.
- To make efficient for various spectrometric analyses
- Demonstrate, solve and an understanding of major concepts in all disciplines of chemistry.
- Solve the problem and also think methodically, independently and draw a logical conclusion.
- Employ critical thinking and the scientific knowledge to design, carry out, record and analyses the results of chemical reactions.
- Create an awareness of the impact of chemistry on the environment, society, and development outside the scientific community.
- Find out the green route for chemical reaction for sustainable development.
- To inculcate the scientific temperament in the students and outside the scientific community.
- To explain nomenclature, stereochemistry, structures, reactivity, and mechanism of the chemical reactions.
- Identify chemical formulae and solve numerical problems.
- Know structure-activity relationship.
- Understand good laboratory practices and safety.

Programme Framework (Courses and Credits): B. Sc. Chemistry

Sr. No.	Year	Semester	Level	Course Type	Course Code	Title	Credits
1.	I	I	4.5	DSC-01	BS-CH 111T	Fundamentals of Chemistry - I	02
2.	I	I	4.5	DSC-02	BS-CH 112P	Chemistry Practical - I	02
3.	I	II	4.5	DSC-03	BS-CH 121T	Fundamentals of Chemistry - II	02
4.	I	II	4.5	DSC-04	BS-CH 122P	Chemistry Practical -II	02

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's
New Arts, Commerce and Science College, Ahmednagar
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Syllabus

B. Sc. -I (Chemistry)

Title of the Course: Fundamentals of Chemistry - I								
Year: I				Semester: I				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-01	BS- CH 111T	02	00	**02**	**30**	15	35	50

Learning Objectives:

Students will-

1. Learn different branches of chemistry.
2. be acquainted with the structure of atom.
3. understand periodic table and trends in periodic properties for s and p block elements
4. learn nomenclature and functional groups.
5. be acquainted with the fundamentals of Analytical Chemistry.

Course Outcomes (COs):

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

1. Understand atomic structure.
2. Understand rules for filling electrons in orbitals and periodicity in properties of elements.
3. Learn methods of preparation of different functional groups.
4. Learn about analytical calculations for preparation of solutions.

Unit I: Atomic Structure **(07)**

Recapitulation of models of atom, Origin of Quantum Mechanics, Comparison of classical and quantum mechanics- i) Black body radiation ii) Photoelectric effect iii) Wave particle duality- a) Particle character of electromagnetic radiation b) Wave character of particle, iv) diffraction by double slit v) atomic spectra, Bohr's theory and its limitations, Heisenberg Uncertainty principle, Sommerfeld modification of Bohr's theory.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it, Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular wave functions, nodes and their significance. Quantum numbers and significance of quantum numbers, Shapes of s, p and d atomic orbitals, electronic configuration and rules for it.

Unit II: Chemistry of Elements (08)

Introduction: Periodic table: Review of periodic table after 150 years, Periodicity of elements: Rules for filling electrons in various orbitals, electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, anomalous electronic configurations, long form of periodic table: s, p, d and f block elements.

Detailed discussion of following properties of elements with reference to s and p block: i) Atomic and ionic radii, ii) Effective nuclear charge, iii) shielding effect, iv) Ionization energies, v) Electronegativity (Pauling's electronegativity scale) vi) Oxidation states of elements.

Unit III: Chemistry of Functional Groups (07)

Basics of Organic Chemistry, nomenclature and methods of preparations of different functional groups (two methods for each):

i)Alkane- Wurtz reaction, From Olefin, ii) Alkene- From alkyl halide and alcohol, iii) Alkyne- From Alkyl dihalide and Calcium Carbide, iv) Alkyl halide- From Alkene and Alcohol, v) Alcohol- From Alkene and Alkyl halide, vi) Acid- From Alcohol and Nitrile, vii) Ester- From Acid and Phenol, viii) Ether – From Alkyl halide and Williamson synthesis, ix) Aldehyde- From Alcohol and Acyl Chloride, x) Ketone- From Alcohol and F. C. Acylation and xi) Amines- From Amide and Nitrile.

Unit IV: Calculations Used in Chemistry Laboratory (08)

Analytical Chemistry - the analytical perspectives, important units of measurements- SI units, distinction between mass and weight, mole, millimole and Calculations, significant figures. Solution and their concentrations- Normal and Molar solutions, Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, Percent Concentration, part per million, part per billion, part per thousand, density and specific gravity of solutions, Empirical and Molecular Formulas, Stoichiometric Calculations, Problems related to preparation of solutions.

Suggested Reading:

1. Bahl Arun, Bahl B. S., Tuli G. D., Essentials of Physical Chemistry, S. Chand, 2016.
2. Atkins Peter. W., Paula Julio, Keeler J., Atkin's Physical Chemistry, 11th Edition, Oxford University Press, 2018.
3. Lee, J. D. Concise Inorganic Chemistry, ELBS, 1991.

4. Cotton, F. A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd edition, Wiley.
5. Douglas, B.E., McDaniel, D.H., Concepts and Models in Inorganic Chemistry, John Wiley and Sons.
6. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
7. Stanley R. Sandler and Wolf Karo, Organic Functional Group Preparations Volume-3, Academic Press.
8. Jonathan Clayden, Nick Greeves, and Stuart Warren, Organic Chemistry, 2nd edition, Oxford University Press, 2012.
9. McMurry J.E. Fundamentals of Organic Chemistry, 9th edition, Cengage Learning, UK, 2016.
10. Skoog D. A, West D. M, Holler F J., Fundamentals of Analytical Chemistry, 9th edition,2009.

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Syllabus

B. Sc. -I (Chemistry)

Title of the Course: Chemistry Practical - I								
Year: I					Semester: I			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-02	BS-CH 112P	00	02	02	**60**	15	35	50

Learning Objectives:

Students will-

1. know importance and use of MSDS sheets and safety symbols, Practice safe working procedures
2. learn synthesis of inorganic compounds.
3. understand the concentrations of solutions and learn volumetric estimation analysis of commercial product
4. understand chromatographic techniques.

Course Outcomes (COs)

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

1. develop practical skills.
2. prepare solutions of required concentrations and practice volumetric analysis.
3. know importance of chemical and lab safety, meaning of safety symbols and precautions in handling hazardous chemicals.
4. learn simple inorganic preparations.
5. learn paper chromatography for separation of mixtures.

Detailed Syllabus:

Preform minimum 12 experiments

Unit I: Chemical and Lab Safety (Compulsory)

1. Introduction of laboratory equipment.
2. Toxicity of compounds used in chemical laboratories and safety symbols on labels of pack of chemicals and their meaning.
3. Material Safety Data Sheet (MSDS) for chemicals like $K_2Cr_2O_7$, benzene, cadmium nitrate and sodium metal.
4. Precautions in handling hazardous substances in laboratory (e.g. conc. acids, ammonia, organic solvents, etc.)

Unit II: Physical Chemistry Practical (Any Two)

5. Determination of heat capacity of calorimeter.
6. Determination of molar gas constant by eudiometric method.
7. Determination of viscosity of given liquid by using Ostwald's viscometer.

Unit III: Preparation of Inorganic Compounds (Any Two)

8. Preparation of Hexamminenickel(II) chloride complex.
9. Preparation of Tetramminecopper(II) sulphate monohydrate complex.
10. Preparation of Chloropentamminecobalt(II) chloride complex.

Unit IV: Paper Chromatographic Technique (Any Two)

11. Separation of commercial ink by paper chromatography.
12. Separation of chlorophyll pigment from spinach leaves by paper chromatography.
13. Separation of metal ions by paper chromatography.

Unit V: Analytical Chemistry Practical (Any Two)

14. Preparation of normal and molar solutions of compounds.
15. Determination of composition of alkali mixture by double indicator method.
16. Estimation of Aspirin from APC tablet.

Suggested Readings / Materials:

1. Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, DOI 10.17226/12654, National Academies Press Washington.
2. Hill Robert H. Jr., Finster David C. Laboratory Safety for Chemistry Students, 2nd Edition, Wiley, 2016
3. Practical Chemistry, Panday, Bajpai, Giri, S. Chand and Co.
4. Khosla B. D., Garg V. C. and Gulati A, Senior Practical Physical Chemistry, R. Chand and Company, New Delhi, 2011.
5. Experimental Physical Chemistry by Athawale and Parul Mathur, New Age International Publication, 2001.
6. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House, 2018.
7. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
8. Experiments in Chemistry, D. V. Jahagirdar, Himalaya Publication.
9. Vogel A. I. Qualitative Organic Analysis, 4th edition (ELBS).

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Syllabus

B. Sc. -I (Chemistry)

Title of the Course: Fundamentals of Chemistry - II								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-01	BS-CH 121T	02	00	**02**	**30**	15	35	50

Learning Objectives:

Students will -

1. know laws of chemical thermodynamics and thermochemistry.
2. learn types of chemical analysis and analysis of organic compounds.
3. understand types of organic reactions and their mechanisms.
4. learn types of chemical bonds and structures of simple molecules.

Course Outcomes (CO's):

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

1. explain terms and laws of chemical thermodynamics.
2. discuss different types of chemical analysis of organic compounds.
3. identify type of an organic reaction and its mechanism.
4. able to correlate the properties of chemical compounds with the type of bond.

Unit I: Chemical Energetics **(08)**

Introduction to thermodynamics, heat, work, internal energy, enthalpy and first law of thermodynamics, importance of state functions: internal energy and enthalpy, entropy and second law of thermodynamics. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Combined statement of first and second law of thermodynamics. Statement of Third Law of thermodynamics, calculation of absolute entropies of substances. Recapitulation of basic terms of thermochemistry.

Unit II: Chemical Analysis **(07)**

Introduction, chemical analysis, applications of chemical analysis, types of analysis- qualitative and quantitative analysis. sampling, common techniques, instrumental methods, other techniques, factors affecting on choice of method. Use of analytical chemistry to solve problems (A case study on toxicology – Ref. 5)

Analysis of Organic Compounds -

Types of organic compounds. a) Characteristic tests and reactions of different functional groups. b) Analysis - Estimation of C, H and (O) by combustion tube, c) Detection of nitrogen, sulphur, halogen and phosphorus by Lassaigne's test. d) Estimation of nitrogen by Kjeldahl's method, e) Estimation of Halogen, Sulphur and Phosphorus by Carius method.

f) Determination of empirical and molecular formula, Numerical problems.

Unit III: Organic Reaction Mechanism **(08)**

Introduction, types of reagents – electrophile, nucleophile and free radical. Types of organic reactions: addition, elimination, substitution and rearrangement reactions. Mechanism of: (i) Aldol condensation (ii) Markovnikov and anti-Markovnikov addition (iii) Saytzeff and Hoffman elimination (iv) S_N1 and S_N2 reactions (v) Hofmann rearrangement and Pinacol-pinacolone rearrangement.

Unit IV: Chemical Bonding **(07)**

Attainment of stable electronic configurations and Lewis concept

Types of Chemical bonds and formation of ionic, covalent, coordinate and metallic bonds.

Ionic Bond: General characteristics of ionic bonding, factors influencing the formation of ions (cations – ionization energies, anions – electron affinity)

Covalent bond: Valence Bond Approach – Postulates, Overlap of atomic orbitals, sigma and pi bonds, formation of H_2, Li_2, C_2, B_2, N_2, O_2 and F_2 molecules, Concept of Hybridization and its types, Structures of BeF_2, BF_3, CH_4, PCl_5, SF_6, C_2H_4, C_2H_2 and CO_2 molecules on the basis of hybridization.

VSEPR theory: Assumptions, need of theory, effect of lone pairs and electronegativity, Isoelectronic principle, examples using VSEPR theory- NH_3, H_2O, PCl_5, ClF_3.

Structures of - i) ClF_3 ii) Cl_2O iii) BrF_5 iv) XeO_3 v) $XeOF_4$, vi) SF_4, vii) I_3^-

Suggested Reading:

1. Thermodynamics for Chemists by Samuel Glasstone, Narahari Press, 2007.
2. Elements of Physical Chemistry by Peter Atkins and Julio de Paula, Sixth edition, Oxford Uni. Press, 2013.
3. Principles of Physical Chemistry by B.R. Puri, L.R. Sharma and M.S. Pathania, 46th Edn. Vishal Pub. Company, 2013.
4. Chemistry by Raymond Chang, MacGraw – Hill, 5th Edn., 1994.
5. Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch, 10th Edn., Cengage Learning, 2021.
6. Basic Concepts of Analytical Chemistry by S. M. Khopkar, New Age Int. Ltd., 2nd Edn., 2004.
7. Vogel's Textbook of Practical Organic Chemistry by B.S. Furniss, A. J. Hannaford, P. W. G. Smith, 5th Edn. Longman Scientific and Technical, 1989.
8. Organic Reactions and Their Mechanisms by P. S. Kalsi, New Age Int. Ltd., 4th Edn., 2017.
9. Organic Chemistry by T.W. Graham Solomon, C.B. Fryhle & S. A. Dnyder, John Wiley & Sons, 2014.
10. Fundamentals of Organic Chemistry by J. E. McMurry, 7th Edn. Cengage Learning India Edition, 2013.
11. Chemistry in Context by Graham C, Hill and John S. Holman, 4th Edn., ELBS, 1995.
12. Concise Inorganic Chemistry by J. D. Lee, 5th Edn. Blackwell Science 1996.
13. Inorganic Chemistry by C. Housecroft, A. G. Sharpe, Pearson Prentice Hall, 2008.
14. Basic Inorganic Chemistry by F. A. Cotton and Wilkinson, 3rd Edn., Wiley, 2007.

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Syllabus

B. Sc. -I (Chemistry)

Title of the Course: Chemistry Practical - II								
Year: I				Semester: II				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-02	BS-CH 122P	00	02	**02**	**60**	15	35	50

Learning Objectives:

Students will -

1. understand the concepts of thermodynamics and their applications.
2. Prepare of buffer solutions and their pH measurement
3. learn Principle and applications of qualitative and quantitative methods of analysis.
4. get knowledge of types of organic reactions.

Course Outcomes (COs):

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

1. apply thermodynamic principles to solve problems in physical and chemical systems.
2. know inorganic estimations using volumetric analysis
3. understand analysis of commercial products
4. perform purification of organic compounds and organic qualitative analysis.
5. prepare simple organic compounds.

Detailed Syllabus:
Preform minimum 12 experiments.

Unit I: Thermochemistry (Any Three)

1. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
2. Determination of enthalpy of ionization of acetic acid.
3. Determination of integral enthalpy of solution of potassium nitrate / ammonium chloride.
4. Determination of enthalpy of hydration of copper sulphate.

Unit II: Volumetric estimations (Any Three)

5. Determination of acetic acid in commercial vinegar by titrating with standard NaOH.

6. Estimation of oxalic acid by titrating it with potassium permanganate.
7. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
8. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

Unit III- Organic qualitative analysis (Any three compounds)

9. Qualitative analysis of organic compounds: Type, preliminary tests, Lassaigne's test, identification of functional groups, confirmatory tests for functional groups.

Unit IV- Organic preparations (Any two)

10. Synthesis of 2,3-dibromo-3-phenylpropanoicacid from cinnamic acid. (Addition reaction)
11. Synthesis of *p*- nitro acetanilide from acetanilide. (Substitution reaction)
12. Synthesis of methyl cyclohexene from 2-methylcyclohexanol. (Elimination reaction)
13. Synthesis of benzillic acid from benzil. (Rearrangement reaction)

Unit V-Preparation of paper models:

14. Making of tetrahedral and octahedral model by using paper/refills.

Suggested Readings / Materials:

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