



Anekant Education Society's

**Tuljaram Chaturchand College**  
**of Arts, Science, Commerce, Baramati**  
**(Autonomous)**

**DEPARTMENT OF CHEMISTRY**

(Faculty of Science and Technology)

**Three Year BSc Degree Program**  
**Chemistry**

**BSc Chemistry 2019 Pattern CBCS**  
**Credit Structure and Syllabus**  
**(To be implemented from June 2019)**

### Credit Structure B.Sc. 2019 Pattern

Class	Pattern	Semester	Course Code	Course Title	Course Type	No. of Credits
<b>First Year</b>						
F.Y.B.Sc	2019	I	CHEM1101	Physical and Inorganic Chemistry I	Theory	02
F.Y.B.Sc	2019	I	CHEM1102	Organic and Inorganic Chemistry I	Theory	02
F.Y.B.Sc	2019	I	CHEM1103	Chemistry Practical I	Practical	03
F.Y.B.Sc	2019	II	CHEM1201	Physical and Inorganic Chemistry II	Theory	02
F.Y.B.Sc	2019	II	CHEM1202	Organic and Inorganic Chemistry II	Theory	02
F.Y.B.Sc	2019	II	CHEM1203	Chemistry Practical II	Practical	03
			Certificate Course			
<b>Second Year</b>						
S.Y.B.Sc	2019	III	CHEM2301	Physical and Analytical Chemistry I	Theory	03
S.Y.B.Sc	2019	III	CHEM2302	Organic and Inorganic Chemistry I	Theory	03
S.Y.B.Sc	2019	III	CHEM2303	Chemistry Practical III	Practical	03
			Certificate Course			
S.Y.B.Sc	2019	IV	CHEM2401	Physical and Analytical Chemistry I	Theory	03
S.Y.B.Sc	2019	IV	CHEM2402	Organic and Inorganic Chemistry I	Theory	03
S.Y.B.Sc	2019	IV	CHEM2403	Chemistry Practical III	Practical	03
			Certificate Course			

Third Year						
T.Y.B.Sc	2019	V	CHEM3501	Physical Chemistry I	Theory	03
T.Y.B.Sc	2019	V	CHEM3502	Inorganic Chemistry I	Theory	03
T.Y.B.Sc	2019	V	CHEM3503	Organic Chemistry I	Theory	03
T.Y.B.Sc	2019	V	CHEM3504	Analytical Chemistry I	Theory	03
T.Y.B.Sc	2019	V	CHEM3505	Industrial Chemistry I	Theory	03
T.Y.B.Sc	2019	V	CHEM3506 A	Nuclear Chemistry I	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3506 B	Polymer Chemistry I	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3506 C	Introduction to Biochemistry and Molecular Biology I	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3506 D	Environmental and Green Chemistry I	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3506 E	Agriculture Chemistry	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3506 F	Synthesis of Nanomaterials and Nano toxicology	Elective Theory	03
T.Y.B.Sc	2019	V	CHEM3507	Physical Chemistry Practical I	Practical	03
T.Y.B.Sc	2019	V	CHEM3508	Inorganic Chemistry Practical I	Practical	03
T.Y.B.Sc	2019	V	CHEM3509	Organic Chemistry Practical I	Practical	03
T.Y.B.Sc	2019	VI	CHEM3601	Physical Chemistry II	Theory	03
T.Y.B.Sc	2019	VI	CHEM3602	Inorganic Chemistry II	Theory	03
T.Y.B.Sc	2019	VI	CHEM3603	Organic Chemistry II	Theory	03
T.Y.B.Sc	2019	VI	CHEM3604	Analytical Chemistry II	Theory	03
T.Y.B.Sc	2019	VI	CHEM3605	Industrial Chemistry II	Theory	03

T.Y.B.Sc	2019	VI	CHEM3606 A	Nuclear Chemistry II	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3606 B	Polymer Chemistry II	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3606 C	Introduction to Biochemistry and Molecular Biology II	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3606 D	Environmental and Green Chemistry II	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3606 E	Dairy Chemistry	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3606 F	Environmental Nanotechnology and Applications	Elective Theory	03
T.Y.B.Sc	2019	VI	CHEM3607	Physical Chemistry Practical II	Practical / Project	03
T.Y.B.Sc	2019	VI	CHEM3608	Inorganic Chemistry Practical II	Practical/ Project I	03
T.Y.B.Sc	2019	VI	CHEM3609	Organic Chemistry Practical II	Practical /Project	03

## Programme Specific Outcomes (PSOs)

**PSO1: Core competency:** The chemistry graduates are expected to gain knowledge of the fundamental concepts of chemistry and applied chemistry through theory and practical. These fundamental concepts would be reflected in the latest understanding of the field to keep continues its progression.

**PSO2: Communication skills:** Chemistry graduates are expected to possess minimum standards of communication skills to read and understand documents so that they can solve their problems very methodically, independently and with logical argument. Graduates are expected to build good communication skill so that they can easily share their idea/finding/concepts to others.

**PSO3: Critical thinking:** Chemistry graduates are expected to achieve critical thinking ability to design, carry out, record and analyse the results of chemical reactions. They can have that much potential and confidence that they can overcome many difficulties with the help of their sharp scientific knowledge and logical approaches.

**PSO4: Psychological skills:** Chemistry graduates are expected to possess basic psychological skills so that they can deal with individuals and students of various socio-cultural, economic and educational levels. Psychological skills are very important for proper mind setting during performing, observing and giving conclusion of a particular reaction. It is also important for self-compassion, self-reflection, interpersonal relationships, and emotional management.

**PSO5: Problem-solving:** Graduates are expected to be well trained with problem-solving philosophical approaches that are pertinent across the disciplines.

**PSO6: Analytical skill development and job opportunity:** Chemistry graduates are expected to possess sufficient knowledge how to synthesize a chemical compound and perform necessary characterization and analysis in support of the formation of the product by using modern analytical tools and advanced technologies. Because of this course curriculum chemistry graduates have lot of opportunity to get job not only in academic and administrative field but also in industry.

**PSO7: Research motivation:** Chemistry graduates are expected to be technically well trained with modern devices and Chemistry based software and has powerful knowledge in different disciplines of Chemistry so they can easily involve themselves in theory and laboratory-based research activities.

**PSO8: Teamwork:** Graduates are expected to be team players, with productive co-operations involving members from diverse socio-cultural backgrounds.

***PSO9: Digital Literacy:*** Graduates are expected to be digitally literate for them to enroll and increase their core competency via e-learning resources such as MOOC and other digital tools for lifelong learning.

***PSO10: Social Awareness:*** As an inhabitant of this green world it is our duty to make our planet clean and suitable for living to all. In this context Chemistry graduates are expected to be more aware about finding green chemical reaction routes for sustainable development. They are expected to maintain good laboratory practices and safety.

## F. Y. B. Sc. SEMESTER- I

### CHEM1101: Physical and Inorganic Chemistry- I (2 credits, 36 L)

#### Course Objective:

1. To develop knowledge of mathematical concepts in chemistry.
2. To develop the knowledge about graphical representation of data.
3. To adequate students with different states of matter and their properties.
4. To enhance problem solving skill in regards to state of matter.
5. To understand different crystal systems of crystalline solids and their properties.
6. To demonstrate chemical Stoichiometry and learn different methods for expression of concentration of solutions.

#### Course Outcome:

1. Students will be able to use mathematical calculations to understand concepts in chemistry.
2. Student should able to plots linear functions to shows the effect of independent variable on dependent variable.
3. Student will be able to analyze the use of calculus in chemistry.
- 4 Student should able to explain the different states of matter with their properties and will be familiar to liquid crystals and their applications.
5. Student will able to identify the structure of crystalline solid in terms of unit cell and finds their structural geometry.
6. Students should able to determine the concentration of solutions in different units such as, molarity, normality, percentage and many more.
7. Student should able to balance the different redox reaction by using oxidation number method and ion electron method.

### SECTION I: PHYSICAL CHEMISTRY (24 L)

#### 1. Chemical Mathematics (6 L)

Functions and variables: Variables as function, variables used in chemistry  
Logarithm - Characteristic and mantissa, Rules of logarithm, Change of sign and base, Problemsbased on pH and pOH calculations.

Derivative: Rules of differentiation, partial differentiation and problems related to chemistry, Integration: Rules of integration, definite and indefinite, problems related to chemistry.

Graph of linear function: Equation of straight line, equation from data of graph, plotting the graphfrom the data of chemical properties, problems.

#### 2. Gaseous and Liquid States (8 L)

Introduction: States of matter and their properties.

Gaseous state: Significance of ideal and kinetic gas equation (no derivation), Real gases- Compressibility factor, Vander Waal's equation of state, critical constants, correlation between critical constants and Vander Waal's constants.

Liquid state: Properties of liquids, vapor pressure and its measurement by isoteniscopic method, Viscosity and its measurements by Ostwald's viscometers,

Liquid crystals: Introduction, their types and applications in various fields.

### 3. Solid State (10 L)

Definition of space lattice, unit cell;

Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices (iii) Law of symmetry, Symmetry elements in crystals.

Fundamental crystal systems, Characteristic of simple cubic, face-centered cubic and body-centered cubic systems, Interlunar distances in cubic crystals, X-ray diffraction by crystals, Derivation of Bragg equation, Determination of crystal structure of NaCl, Numerical problem

## SECTION II: INORGANIC CHEMISTRY (12 L)

### 1. Mole concept and Stoichiometry: (5 L)

Mole concept - Determination of molecular weight by gram molecular volume relationship, problems based on mole concept

Methods of expressing concentration - strength, normality, Molarity, molality, mole fraction, % w/v, % w/w, % v/v, ppt, ppm, ppb,

Standardization of solutions, primary and secondary substances, preparation of standard solutions of acids and bases, problems based on acid base titrations only

### 2. Oxidation –Reduction: (7 L)

Definitions to related terms like oxidation, reduction, oxidizing agent, reducing agent oxidation number, valency,

Balancing of redox reactions using oxidation number method and ion electron method, Problems based on equivalent weight of oxidant and reductant.

### References:

1. Physical Chemistry, P. W. Atkins, ELBS, 5<sup>th</sup> Edition.
2. Principles of Physical Chemistry, Maron and Prutton, 4<sup>th</sup> Edition.
3. Physical Chemistry, G. M. Barrow 4<sup>th</sup> Edition.
4. Quantum Chemistry, I. Levine, 5<sup>th</sup> Edition.
5. Essentials of Physical Chemistry, Bhal and Tuli,
6. Principles of Physical Chemistry, Puri, Sharma and Phathania
7. Mathematical Preparation of Physical Chemistry, F. Daniel, Mc Graw Hill.
8. Concise Inorganic Chemistry, J. D. Lee, 5<sup>th</sup> Edition
9. Concept and Models of Inorganic Chemistry, Douglas and Daniel, 3<sup>rd</sup> Edition
10. Inorganic Chemistry, James Hughey



**Class:** F.Y.B.Sc. (SEM I)

**Subject:** Chemistry

**Course:** Physical and Inorganic Chemistry – I

**Course Code:**

CHEM1101

**Weightage:** 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

### Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0
CO3	3	0	0	0	0	0	0	0	0
CO4	0	0	0	3	0	0	0	0	0
CO5	0	0	0	3	0	0	0	0	0
CO6	0	0	0	0	3	0	0	0	0
CO7	0	0	0	0	0	3	0	0	0

### Justification of Mapping

**PO1: Disciplinary Knowledge:**

CO1. Students will be able to use mathematical calculations to understand concepts in chemistry.

CO2. Student should able to plots linear functions to shows the effect of independent variable on dependent variable.

CO3. Student will be able to analyze the use of calculus in chemistry

**PO4: Research-Related Skills and Scientific Temper:**

**CO4:** Understanding the different states of matter and their properties, including liquid crystals and their applications, aligns with research-related knowledge in materials science (Strong Relation: 3)

**PO5: Trans-Disciplinary Knowledge:**

**CO5:** Identification of crystalline solid structures in terms of unit cells demonstrates knowledge that transcends specific disciplines (Strong Relation: 3)

**PO6: Personal and Professional Competence:**

**CO6:** Determining solution concentrations in different units demonstrates laboratory skills and competence in quantitative analysis (Strong Relation: 3)

**PO7: Effective Citizenship and Ethics:**

**CO7:** Ability to balance redox reactions using appropriate methods signifies an understanding of ethical and accurate chemical practices (Strong Relation)

## CHEM1102: Organic and Inorganic Chemistry I (2 Credits, 36 L)

### Course Objective:

1. To know the fundamental concepts which govern the structure, bonding, properties and reactivity of organic molecules.
2. To become familiar with drawing of organic molecules and arrow pushing concept.
3. Students are expected to know methods of preparation and Chemical reactions of alkanes, alkenes alkynes and homocyclic, aromatic hydrocarbons and application of Hackle's rule.
4. The students are expected to know structure, nomenclature of organic compounds.
5. To understand the use of possible reagents to bring about the given conversion with possible product and identify the major and minor products.
6. To know silent features of periodic table with reference to S-block elements.
7. The students are expected to know separation method by using crown ether, compounds and applications of S block elements.

### Course Outcome:

1. This course makes understanding of structure, bonding, and reactivity of organic molecules.
2. Students are able to draw of organic molecules, and organic compounds.
3. Students are expected to methods of preparation and chemical reactions of alkanes, alkenes, alkynes and aromatic hydrocarbons and application of Huckel's rule.
4. Students should understand the basic properties of organic compounds
5. Students should know the method of naming organic compounds
6. To understand the aliphatic and aromatic hydrocarbons.
7. Students should know details about S block elements.

## SECTION I: ORGANIC CHEMISTRY (24 L)

### 1. Chemical Bonding, structure of Organic Molecules: (5 L)

Covalent bond, Hybridization -  $sp$ ,  $sp^2$  and  $sp^3$  hybridization, Bond length, Bond angle, Bond energy, Inter and Intra molecular forces and their effects  
Drawing organic molecules, zigzag structures, Lewis structure and formal charge,  
Arrow pushingconcept

### 2. Chemistry of Hydrocarbons: (7 L)

Alkanes - Introduction, Nomenclature, Physical properties, Preparations, Reactions of alkanes, Analysis of alkanes

Alkenes-Introduction, higher alkenes, Nomenclature, Physical properties, Preparations, Reactions of alkenes, Analysis of Alkenes

Dienes - Structure & Properties, Conjugated dienes, Reactions of dienes, Analysis of dienes

Alkynes: Introduction, Nomenclature, Physical properties, Preparation, Reactions & analysis of alkynes

Introduction to homocyclic aromatic hydrocarbons (benzene), Huckel's rule of aromaticity, Reactions of benzene – Sulphonation, Nitration, Halogenation, Friedel Craft reactions

### **3. Chemistry of functional groups (12 L)**

Alkyl halides: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of alkyl halides

Alcohols: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of alcohols

Ethers: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of ethers

Carboxylic acids: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of carboxylic acids

Amines: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of amines

Phenols: Introduction, Nomenclature, Physical properties, General methods for preparation, Chemical reactions, Analysis of phenols

## **SECTION II: INORGANIC CHEMISTRY (12 L)**

### **1. Chemistry of S- block elements (12 L)**

Recapitulation of periodic table, special position of Hydrogen in the long form of periodic table, properties of S -block elements with reference to electronic configuration, extraction, trends and properties.

Introduction to crown ether and cryptands, separation of S- block elements using crown ethers. Compounds of S- block elements: oxides, hydroxides, peroxides, superoxide, and halides.

Applications of S-block elements in industrial, biological and agricultural field. Ref. 6 & 9.

#### **References**

1. Organic Chemistry-Clayden, Oxford Uni. Press
2. Organic Chemistry-Morrison and Boyd, 6th Edn.
3. A guide book to Mechanism in Organic Chemistry-Peter Syke, 6th Edn.
4. Stereochemistry of Organic Compounds-Eliel Tata Mc Graw Hill 1989
5. Principles of Physical Chemistry by S.H. Marron & C.F. Pruton, 4th Edn.
6. Concise Inorganic Chemistry-J.D. Lee, 2nd Edition-Relevant pages.
7. Concept & model of Inorganic Chemistry-Douglas Mc Doniels, 3rd Edn.
8. New guide to Modern Valance Theory-G.I. Brown, 3rd Edn.
9. Inorganic Chemistry-James Hughey
10. General Chemistry - Raymond Chang

**Class:** F.Y.B.Sc. (SEM I)

**Subject:** Chemistry

**Course:** Organic and Inorganic Chemistry  
CHEM1102

**Course Code:**

**Weightage:** 1=weak or low relation, 2=moderate or partial relation, 3=strong or direct relation

### Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	3	0	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0
CO4	0	0	0	3	0	0	0	0	0
CO5	0	0	0	3	0	0	0	0	0
CO6	0	0	0	0	0	3	0	0	0
CO7	0	0	0	0	0	0	3	0	0

### Justification of Mapping:

**PO1: Disciplinary Knowledge:**

**CO1:** This course makes understanding of structure, bonding, and reactivity of organic molecules.

**CO2:** Students are able to draw of organic molecules, and organic compounds.

**PO3: Social Competence:**

**CO3:** Knowledge of methods of preparation and chemical reactions of various organic compounds demonstrates practical skills and hands-on training (Strong Relation: 3)

**PO4: Research-Related Skills and Scientific Temper:**

**CO4:** Students should understand the basic properties of organic compounds

**CO5:** Students should know the method of naming organic compounds

**PO6: Personal and Professional Competence:**

**CO6:** Understanding aliphatic and aromatic hydrocarbons showcases competence in the field of organic chemistry (Strong Relation: 3)

**PO7: Effective Citizenship and Ethics:**

**CO7:** Knowledge about S block elements shows an understanding of broader chemical principles, contributing to ethical and accurate chemical practices (Strong Relation: 3)

## CHEM1103: Chemistry Practical I (03 Credits, 12 P)

### Course Objective:

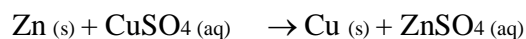
1. To introduce chemical and laboratory safety.
2. To adequate students with graph of various functions.
3. To learn basic of chemistry practical from all the discipline of chemistry.
4. .To learns the estimation of compounds.
5. To know the synthesis of derivatives.
6. To learn the volumetric analysis.
7. To know the preparation of solutions.

### Course Outcome:

1. Basic experiments across chemistry disciplines applying theoretical principles demonstrate comprehensive subject knowledge (Strong Relation: 3)
2. Application of mathematical knowledge in evaluating experimental data showcases critical thinking and analytical skills (Strong Relation: 3)
3. Understanding heat of reaction and its calculations contribute to social competence by applying quantitative analysis techniques (Strong Relation: 3)
4. Development of chromatography skills for substance identification aligns with research-related experimental abilities (Strong Relation: 3)
5. Estimating sample composition volumetrically demonstrates trans-disciplinary knowledge by applying quantitative analysis techniques (Strong Relation: 3)
6. Application of experimental knowledge for identification of cations and anions showcases personal competence in laboratory-based analytical skills (Strong Relation: 3)
7. Being aware of MSDS data for various chemicals signifies a commitment to safety and ethical practices

#### A. Physical Chemistry (Minimum 4 experiments)

1. Sketch the polar plots of S and P Orbital.
2. Assign the lattice structure of NaCl crystal by given data.
3. Determine the gas constant R in various units by eudiometer method.
4. Determine  $\Delta H$  and  $\Delta S$  for the following chemical reaction



5. Determine the heat of solution of  $\text{KNO}_3 / \text{NH}_4\text{Cl}$

**B. Inorganic Chemistry (Minimum 4 experiments)**

1. Determine the hardness of water from a given water sample by EDTA method.
2. Determine the number of water molecules of  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O} / \text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ .
3. Standardization of  $\text{KMnO}_4$  solution and find the strength of given solution.
4. Inorganic Qualitative analysis (TWO mixtures without phosphate and bora

**C. Organic Chemistry (Minimum 4 Experiments)**

1. Determine the amount of acetic acid in commercial vinegar volumetrically.
2. Techniques: (Micro scale) i. Crystallization ii. Sublimation iii. Thin layer chromatography
3. Organic Qualitative analysis of single compound (at least one compound in each type) Type, Preliminary tests, and Physical constant

**References:**

1. Senior Practical physical chemistry, Khosala and Garg.
2. Textbook of qualitative analysis, A. I. Vogel 4<sup>th</sup> Edition
3. Textbook of practical organic chemistry, A. I. Vogel.

**Class:** F.Y.B.Sc. (SEM I)

**Course:** Physical and Inorganic Chemistry – I  
1103

**Subject:** Chemistry

**Course Code:** CHEM

**Weightage:** 1=weak or low relation,2=moderate or partial relation,3=strong or direct relation

**Mapping of Course Outcomes with Program Outcomes**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	0	0	0	0	0	0	0	0
CO2	0	3	0	0	0	0	0	0	0
CO3	0	0	3	0	0	0	0	0	0
CO4	0	0	0	3	0	0	0	0	0
CO5	0	0	0	0	3	0	0	0	0
CO6	0	0	0	0	0	3	0	0	0
CO7	0	0	0	0	0	0	3	0	0

**Justification of Mapping:**

**PO1: Disciplinary Knowledge:**

**CO1:** Basic experiments across chemistry disciplines applying theoretical principles demonstrate comprehensive subject knowledge (Strong Relation: 3)

**PO2: Critical Thinking and Problem Solving:**

**CO2:** Application of mathematical knowledge in evaluating experimental data showcases critical thinking and analytical skills (Strong Relation: 3)

**PO3: Social Competence:**

**CO3:** Understanding heat of reaction and its calculations contribute to social competence by applying quantitative analysis techniques (Strong Relation: 3)

**PO4: Research-Related Skills and Scientific Temper:**

**CO4:** Development of chromatography skills for substance identification aligns with research-related experimental abilities (Strong Relation: 3)

**PO5: Trans-Disciplinary Knowledge:**

**CO5:** Estimating sample composition volumetrically demonstrates trans-disciplinary knowledge by applying quantitative analysis techniques (Strong Relation: 3)

**PO6: Personal and Professional Competence:**

**CO6:** Application of experimental knowledge for identification of cations and anions showcases personal competence in laboratory-based analytical skills (Strong Relation: 3)

**PO7: Effective Citizenship and Ethics:**

**CO7:** Being aware of MSDS data for various chemicals signifies a commitment to safety and ethical practices