AC – 24-05-2024
Item No. – 6.8

As Per NEP 2020

University of Mumbai

Title of the program

A- U.G. Certificate in **Chemistry**
B- U.G. Diploma in **Chemistry**
C- B.Sc. (**Chemistry**)
D- B.Sc. (Hons.) in **Chemistry**
E- B.Sc. (Hons. with Research) in **Chemistry**

Syllabus for

Semester – Sem I and II (Scheme III)

Ref: GR dated 20th April, 2023 for Credit Structure of UG

(With effect from the academic year 2024-25 Progressively)

University of Mumbai

(As per NEP 2020)

Sr. No.	Heading	Particulars	
1	**Title of program** **O: _____A**	**A**	**U.G. Certificate in Chemistry**
	O: _____B	**B**	**U.G. Diploma in Chemistry**
	O: _____C	**C**	**B.Sc. (Chemistry)**
	O: _____D	**D**	**B.Sc. (Hons.) in Chemistry**
	O: _____E	**E**	**B.Sc. (Hons. with Research) in Chemistry**
2	**Eligibility** **O: _____A**	**A**	12th Science of all recognized Board **OR** Passed Equivalent Academic Level 4.0
	O: _____B	**B**	Under Graduate Certificate in Chemistry **OR** Passed Equivalent Academic Level 4.5
	O: _____C	**C**	Under Graduate Diploma in Chemistry **OR** Passed Equivalent Academic Level 5.0
	O: _____D	**D**	Bachelors of Chemistry with minimum CGPA of 7.5 **OR** Passed Equivalent Academic Level 5.5
	O: _____E	**E**	Bachelors of Chemistry with minimum CGPA of 7.5 **OR** Passed Equivalent Academic Level 5.5
3	**Duration of program** **R: _____**	**A**	One Year
		B	Two Years
		C	Three Years
		D	Four Years
		E	Four Years
4	**Intake Capacity** **R: _____**	**120**	

5	**Scheme of Examination** **R: _____**	NEP 40% Internal 60% External, Semester End Examination Individual Passing in Internal and External Examination	
6	**R: _____ Standards of Passing**	40%	
7	**Credit Structure** **Sem. I - R: _____A** **Sem. II - R: _____B**	Attached herewith	
	Credit Structure **Sem. III - R: _____C** **Sem. IV - R: _____D**		
	Credit Structure **Sem. V - R: _____E** **Sem. VI - R: _____F**		
8	**Semesters**	A	Sem I & II
		B	Sem III & IV
		C	Sem V & VI
		D	Sem VII & VIII
		E	Sem VII & VIII
9	**Program Academic Level**	A	4.5
		B	5.0
		C	5.5
		D	6.0
		E	6.0
10	**Pattern**	Semester	
11	**Status**	New	
12	**To be implemented from Academic Year Progressively**	From Academic Year: 2024-25	

Sign of the **Dr. Sunil Patil** **Co-ordinator,** **Board of Studies in Chemistry**	**Sign of the** **Prin. (Dr.) Madhav Rajwade** **Offg. Associate Dean,** **Faculty of Science and Technology**	**Sign of the** **Prof. (Dr.) Shivram Garje** **Offg. Dean,** **Faculty of Science and Technology**

Preamble

1) Introduction

This program is designed to provide a basic understanding of Chemistry. The B.Sc (Chemistry) is framed to equip students with a basic theoretical foundation, practical skills, and critical thinking abilities necessary to address the challenges and opportunities in the diverse fields of the subject. There is continuous evaluation of students based on quizzes, class tests and assignments. Emphasis is given to conceptual understanding of theoretical concepts followed by inclusion of the same in practicals.

2) Aims and Objectives

The aims and objectives of the B.Sc (Chemistry) course are designed to provide students with a foundational understanding of the principles and applications of chemistry. These aims and objectives align with broader educational goals, focusing on academic, practical, and professional development.

3) Learning Outcomes

To demonstrate an understanding of fundamental principles in inorganic, organic, and physical chemistry. To initiate a process to continuous learning and self-improvement. To cultivate a curiosity-driven approach to scientific inquiry. To identify potential career paths in chemistry-related fields such as pharmaceuticals, materials science, and environmental science. To apply acquired skills to entry-level positions in industries requiring a foundation in chemistry.

4) Any other point (if any)

The skills and knowledge acquired during this program will strengthen the students for basic knowledge of the subject.

5) Credit Structure of the Program (Sem I, II, III, IV, V & VI)

Under Graduate Certificate in Chemistry

Credit Structure (Sem. I & II)

	R:_____A								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC, RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
4.5	I	4 **M3-1** Basics in Physical, Inorganic and Organic Chemistry I **M3CHP1:** Chemistry Practical 1 **(M3 of other two Subjects of 4 + 4 Credits)**	-	-	-	**VSC:2, VSCCH1:** Calibration of Glassware and Instruments **SEC:2** Sampling Techniques **OR** Basic Statistical Tools in Chemistry	AEC:2, VEC:2, IKS:2	-	22	**UG Certificate 44**
	R:_____B									
	II	4 **M3-2:** Basics in Physical, Inorganic and Organic Chemistry II **M3CHP2:** Chemistry Practical 2 **(M3 of other two Subjects of 4 + 4 Credits)**			2	**VSC:2, VSCCH2:** Commercial Analysis of Food Samples **SEC:2** Data Analysis in Chemistry **OR** Softwares in Chemistry	AEC:2,	CC:2	22	
	Cum Cr.	24	-	-	2	4+4	4+2+2	2	44	

Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Majorand Minor

Under Graduate Diploma in Chemistry

Credit Structure (Sem. III & IV)

	R:_____C								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC,RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.0	III	8 **Paper I: M3-3 OR MJ5:** Progressive Physical and Analytical Chemistry I **Paper II: M3-4 OR MJ6:** Progressive Inorganic and Organic Chemistry I **Practical I: M3CHP3 OR MJCHP3:** Chemistry Practical 3 **Practical II: M3CHP4 OR MJCHP4:** Chemistry Practical 4		4	2	VSC:2, **VSCCH 3:** Soil Analysis	AEC:2	FP: 2 CC:2	22	**UG Diploma 88**
	R:_____D									
	IV	8 **Paper I: M3-5 OR MJ7:** Progressive Physical and Analytical Chemistry II		4	2	SEC:2	AEC:2	CEP: 2 CC:2	22	

		Paper II: M3-6 OR MJ8: Progressive Inorganic and Organic Chemistry II **Practical I: M3CHP5 OR MJCHP5**: Chemistry Practical 5 **Practical II: M3CHP6 OR MJCHP6:** Chemistry Practical 6								
	Cum Cr.	28		10	12	6+6	8+4+2	8+4	88	
Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continuewith Major and Minor										

B.Sc. (Chemistry)

Credit Structure (Sem. V & VI)

	R:_____E								
Level	**Semester**	**Major**		**Minor**	**OE**	**VSC, SEC (VSEC)**	**AEC, VEC, IKS**	**OJT, FP, CEP, CC,RP**	**Cum. Cr. / Sem.**	**Degree/ Cum. Cr.**
		Mandatory	**Electives**							
5.5	V	10 **Paper I: M3-7 OR MJ9:** Physical and Analytical Chemistry **Paper II: M3-8 OR MJ10**: Organic and Inorganic Chemistry **Paper III: M3-9 OR MJ11**: IKS - Ancient Indian Chemistry **Practical I: M3CHP7 OR MJCHP7**: Chemistry Practical 7 **Practical II: M3CHP8 OR MJCHP8:** Chemistry Practical 8	4	4		VSC: 2 **VSCCH4** Commercial Analysis of Water Samples		FP/CEP:2	22	**UG Degree 132**

R:_____F								
VI	10 **Paper I: M3-10 OR MJ12**: Physical and Analytical Chemistry **Paper II: M3-11 OR MJ13:** Inorganic Chemistry **Paper III: M3-12 OR MJ14:** Organic Chemistry **Practical I: M3CHP9 OR MJCHP9:** Chemistry Practical 9 **Practical II: M3CHP10 OR MJCHP10**: Chemistry Practical 10	4	4				OJT :4	22
Cum Cr.	48	8	18	12	8+6	8+4+2	8+6+4	132

Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor

[Abbreviation - OE – Open Electives, VSC – Vocation Skill Course, SEC – Skill Enhancement Course, (VSEC), AEC – Ability Enhancement Course, VEC – Value Education Course, IKS – Indian Knowledge System, OJT – on Job Training, FP – Field Project, CEP – Continuing Education Program, CC – Co-Curricular, RP – Research Project]

Syllabus
B.Sc. (Chemistry)
SEMESTER I

Sr.No.	Heading	Particulars
1	**Description the Course:**	This program is designed to provide a basic understanding of Chemistry. The B.Sc (Chemistry) is framed to equip students with a basic theoretical foundation, practical skills, and critical thinking abilities necessary to address the challenges and opportunities in the diverse fields of the subject. There is continuous evaluation of students based on quizzes, class tests and assignments. Emphasis is given to conceptual understanding of theoretical concepts followed by inclusion of the same in practicals. B.Sc. (Chemistry) programme offers two majors , one minor, VSCs, SECs, IKS, AECs, OEs VEC and CC. After successful completion of the first year B.Sc. programme the learner will be awarded a UG Certificate in Chemistry.
2	**Vertical:**	Major
3	**Type:**	Theory and Practical
4	**Credits:**	Credits per Semester Theory: 2 Credits (1 Credit = 15 Hours for Theory) Practicals: 2 Credits (1 Credit = 30 Hours for Practicals)
5	**Hours Allotted:**	Hours per Semester Theory: 30 Hrs. Practicals: 60 Hrs.
6	**Marks Allotted:**	Marks per Semester Theory: 50 Marks Practicals: 50 Marks
7	**Course Objectives (CO):**	
	CO 1.	To understand the basic concept of viscosity, preparation of solutions, kinetics, rate laws and determination of orders of reactions.
	CO 2.	To understand basic concepts of electrochemistry, thermodynamics and surface tension
	CO 3.	To comprehend the history of atomic structure, periodicity and properties of elements.
	CO 4.	To distinguish the qualitative methods for identification of inorganic compounds; types of chemical bonds in molecule/ compounds and theories.
	CO 5.	To develop critical thinking about different types of organic compounds and about stereochemical approach of organic compounds
	CO 6.	To develop understanding in organic reaction mechanisms, bonding and structure of organic compounds.
8	**Course Outcomes (OC):**	
	OC 1.	The learner will be able to learn concepts related to state of matter and different methods of concentration expressions and rate laws
	OC 2.	The learner will be able to acquire the knowledge related to electrochemistry, thermodynamics and surface tension
	OC 3.	The learner will be able to classify the elements on the basis of theory learnt and will understand the historical perspective of atomic structure.

	OC 4.	The learner will be able to identify different methods of qualitative analysis and various theories of chemical bonds.
	OC 5.	The learner will be able to identify the organic compounds on the basis of nomenclature and stereochemistry
	OC 6.	The learner will be able to exemplify different organic reaction mechanisms and hybridization involved in organic compounds.

9	**Modules**

Semester	Paper	Module	Description	Credits
I	**M3-1** Basics in Physical, Inorganic and Organic Chemistry I	**I**	**Physical Chemistry** 1.1 Liquid State 1.2 Chemical Calculations 1.3 Chemical Kinetics	**02**
		II	**Inorganic Chemistry** 2.1 Atomic Structure 2.2 Periodic Table and Periodicity	
		III	**Organic Chemistry** 3.1 Classification and Nomenclature of Organic Compounds 3.2 Stereochemistry	
	M3CHP1: Chemistry Practical 1		**Practical Component**	**02**
II	**M3-2:** Basics in Physical, Inorganic and Organic Chemistry II	**I**	**Physical Chemistry** 1.1 Liquid State 1.2 Gaseous State 1.3 Electrochemistry 1.4 Chemical Thermodynamics	**02**
		II	**Inorganic Chemistry** 2.1 Concept of Qualitative Analysis 2.2 Chemical Bond and Reactivity	
		III	**Organic Chemistry** 3.1 Fundamentals of Organic Reaction Mechanism 3.2 Bonding and Structure of Organic Compounds	
	M3CHP2: Chemistry Practical 2		**Practical Component**	**02**

Sem. - I

Mandatory

M3-1 Basics in Physical, Inorganic and Organic Chemistry I

Module I	**Physical Chemistry (10L)**
1.1	**Liquid State - I: (2L)** **Viscosity:** Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer
1.2	**Chemical Calculations: (2L)** Methods of expressing concentration of solutions: Normality, Molarity, Molality, Mole fractions, ppm, ppb. Preparation of solutions (Dilution). (Numerical problems expected wherever necessary)
1.3	**Chemical Kinetics: (6L)** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, Integrated rate equation of first order and Second order reactions (with equal initial concentration of reactants) . Determination of order of reaction by a) Integration method b) Graphical method c) Ostwald's isolation method d) Half time method (Numerical problems expected wherever necessary).
Module II	**Inorganic Chemistry (10L)**
2.1	**Atomic Structure: (3L)** **Historical perspectives of the atomic structure;** J.J. Thomson Model, Rutherford's Atomic Model- alpha particle scattering experiment, Bohr's theory, Aufbau principle, Hund's rule of maximum multiplicity and Pauli exclusion principle
2.2	**Periodic Table and Periodicity: (2L)** **Long form of Periodic Table:** Classification for elements as main group, transition and inner transition elements. **Periodicity in the Following Properties (5L)** Atomic and ionic size, electron gain enthalpy, ionization enthalpy, effective nuclear charge (Slater's rule), electronegativity, Pauling and Mulliken methods. (Numerical problems expected, wherever applicable.)
Module III	**Organic Chemistry (10L)**
3.1	**Classification and Nomenclature of Organic Compounds: (5L)** **Nomenclature of mono and bi-functional aliphatic compounds on the basis of priority order of the following classes of compounds:** Alkanes, alkenes, alkynes, haloalkanes, alcohols, ethers, aldehydes, ketones, carboxylic acids.
3.2	**Stereochemistry: (5L)** Projection formulae: Flying Wedge projection, Fischer Projection, Newman and Sawhorse Projection formulae (erythro, threo isomers of tartaric acid and 2,3 - dichlorobutane) and their interconversions; **Geometrical isomerism in alkene**: cis–trans and syn-anti isomerism R/S nomenclature, E/Z notations with C.I.P rules. **Conformational analysis of alkanes** (ethane, and n-butane); Relative stability with energy profile diagrams

M3CHP1: Chemistry Practical 1

Physical Chemistry

1) To prepare 0.1 N succinic acid and standardize the NaOH solution of different concentrations.
2) To standardize Sodium thiosulphate solution.
3) To determine the rate constant for the hydrolysis of ester using HCl as catalyst.
4) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature (Any two solutions).

Inorganic Chemistry

1) Volumetric analysis

a) To determine the strength of commercial acid sample (HCl).
b) To estimate the content of Na_2CO_3 and $NaHCO_3$ in the given sample using double indicator.

2) Gravimetric analysis

a) To determine the percent purity of sample of $BaSO_4$ containing NH_4Cl
b) To determine the percent purity of ZnO containing $ZnCO_3$.

Organic Chemistry

1) Purification of organic compounds by recrystallization selecting suitable solvent (minimum 2 Organic compounds to be given)
   (Students are expected to report a) Solvent for recrystallization. b) Percentage Yield and the melting points of the purified compound.)
2) Basic principles involved in characterization of Organic compound (minimum 4 Solid Organic compounds)
   (Students should perform Preliminary Tests, Solubility Test, obtain melting point and recrystallize the compound with given solvent)

Vocational Skill Course (VSC)

Title of the course

VSCCH1: Calibration of Glassware and Instruments

Sr. No.	Heading	Particulars
1	**Description the course:**	The aim of Vocational Skill Courses (VSC) designed to provide experiential learning for students, which help to develop their technical skill through hands-on training and also developing abilities of critical thinking, analytical skill, collaboration, teamwork, problem-solving and communication which mold their careers.
2	**Vertical:**	Vocational Skill Course
3	**Type:**	Theory and Practical
4	**Credits:**	Credits per Semester Theory: 1 Credits (1 Credit = 15 Hours for Theory) Practicals: 1 Credit (1 Credit = 30 Hours for Practicals)
5	**Hours Allotted:**	Hours per Semester Theory: 15 Hrs. Practicals: 30 Hrs.
6	**Marks Allotted:**	50 Marks
7	**Course Objectives (CO):** CO 1. To introduce glassware and instruments used in a Chemistry laboratory. CO 2. To understand the importance of calibration of glassware and instruments in tune with concepts of precision and accuracy. CO 3. To develop awareness about safety measures for handling chemicals. CO 4. To identify and comprehend the major components present in food samples. CO 5. To gain knowledge about various analytical techniques employed in commercial food analysis. CO 6. To develop practical skills for the analysis of food samples.	
8	**Course Outcomes (OC):** **After Completion of the course, the Learner will able to;** OC 1 Calibrate glassware and instruments. OC 2 Understand the concept of minimizing errors. OC 3 Handle various chemicals with the necessary care. OC 4 Identify the various components present in food samples. OC 5 Apply analytical techniques for the analysis of food samples. OC 6 Acquire the necessary basic skills for the analysis of food samples.	

9	**Modules**

Semester	Unit	Description	Credits
I	**I (Theory Component)**	**Calibration of Glassware and Instruments**	
		1.1 Tools of Analytical Chemistry 1.2 Introduction to Analytical Chemistry and Calibration of Laboratory Instruments 1.3 Chemicals and Laboratory Safety	**01**
	II (Practical Component)	2.1 Calibration of Laboratory Glasswares 2.2. Calibration of Laboratory Instruments	**01**
II	**I (Theory Component)**	**Commercial Analysis of Food Samples**	
		1.1 Importance of Food Analysis and Nutrients 1.2 Food Quality and Safety 1.3 Importance of Food Analysis with reference to Important Case Study	**01**
	II (Practical Component)	Practical Component	**01**

Semester I
Calibration of Glasswares and Instruments

Unit	Description	Hours
I **Theory Component**	**1.1 Tools of Analytical Chemistry** 1. Introduction to common laboratory glasswares and instruments used in practical course 2. SOPs for instruments used in practical course 3. Importance of calibration with reference to accuracy, precession and minimization of errors	**04**
	1.2 Introduction to Analytical Chemistry and Calibration of Laboratory Instruments 1. Introduction, types of chemical analysis, general analytical method, primary standard and secondary standard substances. 2. Calibration of Laboratory Glasswares: Burettes, Pipettes, Volumetric Flask, thermometer etc. 3. Calibration of laboratory instruments: pH meter, conductometer, potentiometer and colorimeter.	**08**
	1.3 Chemicals and Laboratory Safety 1. Introduction to pictogram of chemical used. (Acids, Bases, Solvents and Salts) 2. Material Safety Data Sheets with reference to hazardous chemicals like $K_2Cr_2O_7$, Benzene, cadmium nitrate, β-naphthol, CCl_4 and mercury. 3. Precautions in handling of hazardous substances like conc. acids, ammonia, organic solvents like ether and alcohol.	**03**
II **(Practical Component)**	**2.1 Calibration of Laboratory Glasswaress** 1. Calibration of Burette 2. Calibration of Pipette 3. Calibration of Standard Measuring Flask 4. Calibration of Thermometer (Demonstration) **2.2 Calibration of Laboratory Instruments** 1. Calibration of pH meter 2. Calibration of Conductometer 3. Calibration of Colorimeter 4. Calibration of Potentiometer (Demonstration)	**30**

References-

1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2006)
2. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Hollers'. Crouch (2009)
3. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education (1999)
4. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher (2004)
5. Principles of Instrumental Analysis, D. A. Skoog, F. James Holler, Stanley R. Crouch (2007)
6. Vogel's Textbook of Quantitative Chemical Analysis, 5th edition (1989)
7. Instrumental method of analysis, B.K. Sharma, Goel publishing house. Miscellaneous methods (2005)

Skill Enhancement Course (SEC)

Semester I

Title of the course

Sampling Techniques

Sr. No.	Heading	Particulars
1	**Description the Course**	The aim of Skill Enhancement Courses (SECs) is to introduce the students with opportunities to develop required skills in Chemistry
2	**Vertical**	Skill Enhancement Course (SEC)
3	**Type**	Theory and Practical
4	**Credits**	2 Credits (1 Credit = 15 Hours for Theory) (1 Credit = 30 Hours for Practical)
5	**Hours Allotted**	45 Hours
6	**Marks Allotted**	50 Marks
7	**Course Objectives (CO)**	
	CO 1 To understand the fundamentals of sampling including its importance, terms involved, the concept of sample size and types of sampling techniques	
	CO 2 To gain knowledge of traditional and modern preservation methods of liquid and solid samples, their storing and handling so as to maintain their integrity and obtain accuracy in further analysis	
	CO 3 To design a sampling plan tailored to the specific objective	
	CO 4 To develop practical skills for implementing sampling techniques in real-world settings	
	CO 5 To understand the fundamentals of sampling including its importance, terms involved, the concept of sample size and types of sampling techniques	
8	**Course Outcomes (OC)** The student will be able to-	
	OC 1 Conducting sampling procedures in Chemistry, including selecting appropriate methods and equipment for different sample types	
	OC 2 Handling solid and liquid samples according to established protocols to ensure accurate analysis and reliable results	
	OC 3 Critically analyze case studies related to soil and water pollution, applying Chemical principles to identify causes, effects, and remedial measures, and proposing effective solutions and prevention strategies	
9	**Modules**	

Semester	Module	Description	Credits
I	**I (Theory Component)**	1.1 Sampling	**01**
		1.2 Storage, Preservation and Handling of Solid and Liquid Samples	
		1.3 Case Study	
	II (Practical Component)	Practicals	**01**

Module	Description	Hours
I (Theory Component)	Sampling • Introduction to sampling • Importance and problems involved in sampling • Terms involved: Sample, universe, increment, gross sample, sub sample, analysis sample • Concept of sample size: Macro, semi-micro, micro, ultra micro • Types of sampling: Random and non-random sampling • Methods and equipments used in sampling of homogeneous, heterogeneous and flowing liquids • Methods and Equipments used in sampling of solids	**09**
	Storage, Preservation and Handling of Solid and Liquid Samples • Need of preservation • Traditional and modern methods of preservation • Methods of handling of solid and liquid samples	**03**
	Case Study Discussion on the case study related to soil and water pollution and its remedial measures	**03**
II (Practical Component)	**Practicals** (i) Demonstration of sampling techniques for water samples (ii) Demonstration of sampling techniques for soil samples (iii) Collection of soil samples (minimum three) from nearby area and determine pH from the same (iv) Collection of soil samples (minimum three) from nearby area and determine Conductance from the same (v) Collection of water sample from nearby area and determine chloride content from the same (vi) Collection of water sample from nearby area and determine the hardness of the same (vii) Collection of water sample from nearby area and determine the alkalinity of the same (viii) Collection of Water sample from nearby area and determine TDS and TSS from the same	**30**

10. References

1. B. Schrader, ed., Infrared and Raman Spectroscopy: Methods and Applications, Wiley, Chichester, West Sussex, England, 1995.

2. J.J. Laserna, Modern Techniques in Raman Spectroscopy, Wiley, Chichester, West Sussex, England, 1996.

3. N. Bloembergen, Pure Appl. Chem., 59, 1229 (1987).

4. A.B. Harvey, ed., Chemical Applications of Non-linear Raman Spectroscopy, Academic Press, New York, 1981.

5. A. Zumbusch, G. R. Holtom, and X. S. Hie, Phys. Rev. Lett., 82, 4142 (1999).

6. S. A. Asher, C. H. Munro, and Z. Chi, Laser Focus World, 33, 99 (1997).

7. R. L. McCreery, in J. J. Laserna, ed., Modern Techniques in Raman Spectroscopy, Wiley, Chichester, West Sussex, England, 1996.

8. G. J. Puppels, F. F. M. D. Mul, C. Otto, J. Greve, M. Robert-Nicoud, D. J. Arndt-Jovin, and T. Jovin, Nature, 347, 301 (1990). 9. C. J. H. Brenan and W. Hunter, Appl. Opt., 33, 7520 (1994).

Skill Enhancement Course (SEC)

Semester I

Title of the course

Basic Statistical Tools in Chemistry

Sr. No.	Heading	Particulars
1	**Description the Course**	The aim of Skill Enhancement Courses (SECs) is to introduce the students with opportunities to develop required skills in Chemistry
2	**Vertical**	Skill Enhancement Course (SEC)
3	**Type**	Theory and Practical
4	**Credits**	2 Credits (1 Credit = 15 Hours for Theory) (1 Credit = 30 Hours for Practical)
5	**Hours Allotted**	45 Hours
6	**Marks Allotted**	50 Marks

7	**Course Objectives (CO)**	
	CO 1	To understand the significance of data and its types
	CO 2	To learn methods to assess precision and accuracy using statistical measures
	CO 3	To gain proficiency in analyzing data dispersion using statistics
8	**Course Outcomes (OC)** The student will be able to-	
	OC 1	Ability to critically evaluate and categorize different types of data sets, distinguishing between them
	OC 2	Proficiency in utilizing various measures of precision and accuracy to analyze and interpret data
	OC 3	Competence in assessing data dispersion and variability through the application of statistical measures

9	**Modules**

Semester	Module	Description	Credits
I	**I (Theory Component)**	1.1 Introduction, Types and Variables of Data 1.2 Precision and Accuracy	**01**
	II (Practical Component)	Practicals	**01**

Module	Description	Hours
I (Theory Component)	**1.1 Introduction, Types and Variables of Data** • Introduction and importance • Data: Meaning and Types- Primary data and secondary data, Discrete data and continuous data • Variables and their types	**07**

	1.2 Precision and Accuracy • Concept of Precision: Mean, median, mode, range, absolute deviation, average deviation, relative average deviation, standard deviation, variance • Concept of Accuracy: Absolute and relative error • Measures of Dispersion: Percentiles, Mean deviation, Standard deviation (S.D.) Coefficient of variation	**08**
II (Practical Component)	**1)** Determination of mean, median and mode of titre values of acid base titration (Minimum number titre values = 10) **2)** Determination of standard deviation and variance of titre values of any complexometric titration (Minimum number titre values = 10) **3)** Determination of acetic acid in vinegar by potentiometry and calculate absolute and relative error **4)** Determination of Absolute deviation, average deviation and relative average deviation from the given data of any experiments of Chemistry. **5)** Determination of absolute and relative error in standardization of $Na_2S_2O_3$ by using 0.05N $K_2Cr_2O_7$. (The readings of all students of the batch shall be used for calculation and also expert reading shall be provided)	**30**

10. References

1. Analytical Chemistry by Cary D. Christian, John Wiley and sons

2. Basic concepts of Analytical Chemistry by S.M. Khopkar, New Age International Publishers

3. Vogel's Textbook of Quantitative Chemical Analysis by J. Menham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th Edn, Low Price Edition, Pearson Education Ltd, New Delhi (2000)

Sem. – II

Syllabus B.Sc. (Chemistry)
SEMESTER II
M3-2: Basics in Physical, Inorganic and Organic Chemistry II

Module I	Physical Chemistry
1.1	**Liquid State - II: (2L)** **Surface tension:** Introduction, methods of determination of surface tension by Drop number method (Numericals expected)
1.2	**Gaseous State (3L)** Kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (Qualitative discussion), Ideal gas laws, Deviation from ideal gas laws, Ideal and real gases, Reasons for deviation from ideal gas laws, Compressibility factor, Boyle's temperature, van der Waals equation of state (Derivation). (Numericals expected)
1.3	**Electrochemistry (2L)** Conductance, specific conductance, equivalent conductance, molar conductance, Variation of molar conductance with concentration of strong and weak electrolyte. (Numericals expected)
1.4	**Chemical Thermodynamics (3L)** **Thermodynamic Terms:** System, surrounding, boundaries, types of system, Intensive and Extensive properties, Thermodynamic processes. **First law of thermodynamics:** Concept of heat (q), work (w), internal energy (U), enthalpy, heat capacity, relation between heat capacities, sign conventions, calculations of heat, work, internal energy and enthalpy (H) (Numerical problems expected)
Module II	**Inorganic Chemistry**
2.1	**Concept of Qualitative Analysis: (5L)** Testing of Gaseous Evolutes, Role of Papers impregnated with Reagents in qualitative analysis (with reference to papers impregnated with starch iodide, potassium dichromate, lead acetate, dimethylglyoxime and oxine reagents). Precipitation equilibria, Formation of precipitates like AgCl, AgBr, AgI and $BaSO_4$ effect of common ions, uncommon ions, oxidation states, buffer action.
2.2	**Chemical Bond and Reactivity: (5 L)** Types of chemical bond, comparison between ionic and covalent bonds, polarizability (Fajan's Rule), shapes of molecules, Lewis dot structure, Sidgwick Powell Theory, basic VSEPR theory for AB_n type molecules with and without lone pair of electrons, applications and limitations of VSEPR theory.
Module III	**Organic Chemistry**
3.1	**Fundamentals of Organic Reaction Mechanism: (5L)** **Basic terms and concepts**: Homolytic and Heterolytic fission with curly arrows with suitable examples. Electrophiles and Nucleophiles. **Types (primary, secondary, tertiary, allyl, benzyl), shape and their relative stability of the following reactive intermediates**: i. Carbocations ii. Carbanions and iii. Free radicals **Introduction to types of organic reactions:** Addition, Elimination and Substitution reaction. (With one example of each)

3.2	**Bonding and Structure of Organic Compounds: (5L)** **Hybridization:** sp^3, sp^2, sp hybridization of carbon and nitrogen; sp^3 and sp^2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide) **Overlap of atomic orbitals:** Overlaps of atomic orbitals to form sigma and pi bonds, shapes of organic molecules. **Shapes of molecules:** Influence of hybridization on bond properties (as applicable to ethane, ethene, ethyne).

Semester II Practical
M3CHP2: Chemistry Practical 2

Physical Chemistry

1) To determine the amount of strong acid in the given solution by titrating against strong base conductometrically.
2) To determine the dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically.
3) To determine enthalpy of dissolution of salt (KNO_3)
4) To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.

Inorganic Chemistry

Qualitative analysis of simple salts: (4 mixtures to be analyzed)

Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions (from amongst):

Cations (from amongst): Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Mg^{2+}, K^+, $NH4^+$

Anions (from amongst): CO_3^{2-}, SO^{2-}, NO_2^-, NO_3^-, Cl^-, Br^-, I^-, SO_4^{2-}, PO_4

(Scheme of analysis should avoid use of sulphide ion in any form for precipitation/ separation of cations.)

Below are the representative mixture combinations, besides these any other combination will also be taken.

Probable mixture combination:

1) $MgSO_4 + KCl$
2) $CaCl_2 + KNO_3$
3) $CaCO_3 + Mg(NO_3)_2$
4) $BaSO_4 + NH_4Cl$

Organic Chemistry

Characterization of organic compounds containing C, H, (O), N, S, X elements (6 solid/liquid Organic compounds)

(Preliminary Tests, Solubility/Miscibility Test, Detection of Elements, Detection of Functional group and determination of Physical constant)

10. Reference Books:

Physical Chemistry

1) Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2) Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry 10th Ed., Oxford University Press (2014).
3) Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4) Keith J. Laidler & John H. Meiser, Physical Chemistry, 2nd Ed. (2004)
5) Puri B. R., Sharma L. R. & Pathania M. S. Principles of Physical Chemistry, Vishal Publishing Company, 2008
6) Ball, D. W. Physical Chemistry Thomson Press, India (2007).
7) Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).
8) Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
9) McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
10) Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
11) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
12) Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).
13) Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
14) Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.; McGraw-Hill: New York (2003).
15) Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Inorganic Chemistry

1) Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2) Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3) Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry, Oxford, 1970
4) Atkins, P.W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.
5) Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India
6) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
7) Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
8) Advanced Inorganic Chemistry, 17th Edition, by Satyaprakash, G.D.Tuli and R. D. Madan, 2022.

Organic Chemistry

1) Concise Graduate Chemistry – I, II, III & IV, University Text Book of Chemistry, University of Mumbai.
2) Morrison, R. T. and Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt Ltd. (Pearson Education).2012
3) Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
4) Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt Ltd. (Pearson Education).
5) Eliel, E. L. and Wilen, S. H. Stereochemistry of Organic Compounds, Wiley: London, 1994
6) Kalsi, P. S. Stereochemistry Conformation and Mechanism, New Age International, 2005.
7) Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013
8) Paula Y Bruice, Organic Chemistry, 7th Ed, Pearson education, Asia.2014
9) Graham Solomon, Fryhle, Dnyder, Organic Chemistry, Wiley publication. 12 th Ed,2016
10) Bahl and Bahl, Advanced Organic chemistry by S. Chand publication.2010
11) Peter Sykes. Guidebook to the mechanism in Organic chemistry ,6th edition
12) D. Nasipuri. Stereochemistry of Organic Compounds, Principles and Applications, Second Edition
13) Organic Chemistry: A problem solving approach by Lakshmi Ravishankar and Gomathi Shridhar, Narosa Publisher, 2023.
14) Laboratory Experiments in Chemistry I & II, University Practical Book of Chemistry, University of Mumbai.
15) Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
16) Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012).
17) Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

Semester II
Vocational Skill Course (VSC)

Title of the course
VSCCH2: Commercial Analysis of Food Samples

Unit	Description	Hours
I (Theory component)	**1.1 Importance of Food Analysis and Nutrients** Importance of food analysis and basic principles. Nutrients and their nutritional value in food composition, macronutrients and micronutrients	**04**
	1.2 Food Quality and Safety Principles of food safety and quality assurance. Types of additives, their functions and safety considerations. Importance of pH and use of chemical preservatives (Boric acid, Sodium Benzoate) Introduction to foodborne illnesses and prevention methods.	**05**
	1.3 Importance of Food Analysis with reference to Important Case Study **Case Study** (Any One) – Brominated Vegetable Oil (Soft drink) / Nickel in Chocolate / Oxytocin in Milk **Applications of Chemical and instrumental methods in food analysis** 1. Estimation of Vitamin C in lemon squash by redox titration 2. Estimation of Calcium in milk powder by complexometric titration 3. Estimation of Acetic acid in vinegar by potentiometry 4. Estimation of Iron in the given food sample by colorimetry using KSCN.	**06**
II (Practical Component)	1. Measure the pH of given food sample (acidic/basic) using pH meter. 2. Estimation of Vitamin C (Ascorbic Acid) in lemon squash sample by using 2,4-Dichlorophenol indicator 3. Qualitative analysis of macronutrients (two samples each) proteins (Biuret test) Carbohydrates (Benedict's Test) 4. Estimation of Calcium in milk powder by complexometric titration 5. Estimation of acetic acid in preservative (Vinegar) potentiometry. 6. Detection of contaminants or adulterants in the following food samples (Any one adulterant) i) Milk ii) Tea Powder iii) Turmeric powder iv) Chili Powder	**30**

10. References

1. "Food Analysis Laboratory Manual" by S. Suzanne Nielsen
2. "Food Analysis" by James G. Brennan
3. Vogel's Textbook of Quantitative Chemical Analysis, Fifth Edition, G H Jeffery and J Bassett.
4. Vogel,A.I.,Tatchell,A.R.,Furnis,B.S.,Hannaford,A.J.&Smith,P.W.G.,TextbookofPracticalOrganic Chemistry, Prentice-Hall, 5th edition, 1996.
5. FSSI MANUAL OF METHODS OF ANALYSIS OF FOODS: FOOD ADDITIVES

Skill Enhancement Course (SEC)

Semester II

Title of the course

Data Analysis in Chemistry

Sr. No.	Heading	Particulars
1	**Description the Course**	The aim of Skill Enhancement Courses (SECs) is to introduce the students with opportunities to develop required skills in Chemistry
2	**Vertical**	Skill Enhancement Course (SEC)
3	**Type**	Theory and Practical
4	**Credits**	2 Credits (1 Credit = 15 Hours for Theory) (1 Credit = 30 Hours for Practical)
5	**Hours Allotted**	45 Hours
6	**Marks Allotted**	50 Marks
7	**Course Objectives (CO)**	
	CO 1	To understand the significance of SI units in Chemistry and their role in standardizing measurements
	CO 2	To recognize the importance of statistical data analysis in Chemistry for drawing meaningful conclusions from experimental data
	CO 3	To apply rounding off techniques and determine significant figures to ensure accuracy and precision in reporting experimental results
	CO 4	To develop skills in selecting and applying appropriate statistical tests for data analysis
8	**Course Outcomes (OC)** The student will be able to-	
	OC 1	Apply SI units correctly for precise measurement and communication of chemical quantities and properties
	OC 2	Conduct statistical data analysis in Chemistry experiments, enabling informed decision-making and drawing reliable conclusions
	OC 3	Select the appropriate statistical test for analysis and interpret the results correctly

9	**Modules**

Semester	Modules	Description	Credits
I	**I (Theory Component)**	Data Analysis in Chemistry	**01**
	II (Practical Component)	Practicals	**01**

Module	Description	Hours
I (Theory Component)	• SI units and its uses • Importance and need of statistical data analysis in Chemistry • Concept of rounding off an observation from the given data • Concept of significant figures and its importance • Selection and application of statistical tests w.r.t. 2.5d, 4.0d, Q-Test and F-Test • Concept of Student's t • Concept of confidence limits and confidence interval	**15**
II (Practical Component)	**1.** Application of 2.5d rule for a Redox Titration of Ferrous sulphate against $K_2Cr_2O_7$. **2.** Application of 4.0d rule for standardization of NaOH by using succinic acid as primary standard. **3.** Application of Q-Test for the provided data in the gravimetric estimation Ni^{+2} as Ni-DMG. **4.** Determination of confidence limit and confidence interval from the given data. **5.** Determination of significant figures from the given data of any experiments of Chemistry.	**30**

10. References

1. https://www2.chemistry.msu.edu/courses/cem434/Lecture%20_Statistics_Total.pdf

2. https://sites.chem.utoronto.ca/chemistry/coursenotes/analsci/stats/BasicStats.html

3. R.K. Burdick, D. LeBlond, D. Sandell, H. Yang, Statistical methods for validation of procedure accuracy and precision, Pharmacopeial Forum 39 (3) (2013)

4. P. Nethercote, J. Ermer, Quality by design for analytical methods: implications for method validation and transfer, Pharm. Technol. 36 (10), 74–79 (2013)

5. Analytical Chemistry by Cary D. Christian, John Wiley and sons.

6. Basic Concepts of Analytical Chemistry by S.M. Khopkar, New Age International Publishers.

7. Vogel's Textbook of Quantitative Chemical Analysis by J. Menham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th Edn, Low Price Edition, Pearson Education Ltd, New Delhi (2000)

8. Modern Analytical Chemistry, David Harvey (page numbers 53-84)

9. Fundamentals of analytical chemistry –Skoog and West

Skill Enhancement Course (SEC)

Semester II

Title of the course

Softwares in Chemistry

Sr. No.	Heading	Particulars
1	**Description the Course**	The aim of Skill Enhancement Courses (SECs) is to introduce the students with opportunities to develop required skills in Chemistry
2	**Vertical**	Skill Enhancement Course (SEC)
3	**Type**	Theory and Practical
4	**Credits**	2 Credits (1 Credit = 15 Hours for Theory) (1 Credit = 30 Hours for Practical)
5	**Hours Allotted**	45 Hours
6	**Marks Allotted**	50 Marks
7	**Course Objectives (CO)**	
	CO 1	To develop proficiency in utilizing MS-office and other softwares for precise representation of chemical formulae, equations and experimental data and use them to solve chemical equations.
	CO 2	To use online platforms for literature survey
	CO 3	To gain competence in using specialized Chemistry software tools
	CO 4	To enable students to understand MSDS
8	**Course Outcomes (OC)** Students will be able to-	
	OC 1	Proficiently use of MS-Word and MS-Excel for accurately documenting chemical formulae, equations and experimental data, ensuring clarity and precision in scientific communication
	OC 2	Utilization of online platforms to conduct comprehensive literature surveys, and stay updated with advancements in Chemistry
	OC 3	Gain mastery of specialized Chemistry software tools such as ChemDraw/ChemSketch etc.

9	**Modules**

Semester	Modules	Description	Credits
I	**I (Theory Component)**	1.1 ICT Tools in Chemistry	**01**
		1.2 Online Platforms for Literature Survey	
		1.3 Chemistry Softwares	
	II (Practical Component)	Practicals	**01**

Module	Description	Hours
I Theory Component	**1.1 ICT Tools in Chemistry** Use of MS-WORD in writing chemical formulae and equations Use of MS-Excel in treatment of experimental data: Basic functions and formulae, creating charts and graphs, etc.	**05**
	1.2 Online Platforms for Literature Survey Google Scholar, Sci-Finder, Scopus and Web of Science	**02**
	1.3 Chemistry Softwares ChemDraw / ChemSketch: Introduction, Drawing of chemical structures and reactions, Chemical structure to name conversion, chemical name to structure conversion and other related features Origin Software: Introduction, graphs, 2D and 3D graphs and other related features	**08**
II (Practical Component)	**1.** Writing of chemical equations and formulae using MS Word. **2.** Use of Excel sheets in calculation and plotting of graph of rate constants for the given data of hydrolysis of methyl acetate. **3.** Drawing of chemical structure of organic compounds (acyclic, cyclic, polycyclic, heterocyclic) by using ChemSketch / Chem Draw. **4.** Use of Origin software for plotting of graphs for the given data of potentiometric titration of weak acid against strong base. **5.** Drawing of chemical structure of simple organic compounds and determination of molecular weight, molecular formula, refractive index, bond angles, bond lengths by using ChemSketch / Chem Draw 6. Demonstration of Chemistry Experiments using Virtual Laboratory (http://www.chemcollective.org/vlab/vlab.php) (Minimum 3 Experiments)	**30**

10. References

1. "Research Methodology – Methods and Techniques" by C.R. Kothari.

2. "Excel 2019 Charts (Easy Excel Essentials 2019)" by M L Humphrey

3. "Tutorial to ChemDraw: For beginner" by Juhn Morton

4. https://www.chem.uzh.ch/bienz/lecture/gpc/Files/Intro_cdraw.pdf

5. "Origin Software Complete Usage Instruction and Graph Representation: A complete Guide for new users" by Muhammad Arsalan, Azka Awais

https://d2mvzyuse3lwjc.cloudfront.net/pdfs/Origin2022b_Documentation/English/Origin_User_Guide_2022b_E.pdf

QUESTION PAPER PATTERN
(External and Internal)

Evaluation Pattern for Major Theory Course

MAJOR: 4 credits

Semester I

Theory/Practical	Credits	No. of Hours	Marks
Theory: **M3-1:** Basics in Physical, Inorganic and Organic Chemistry I	2	30	50
Practical: **M3CHP1:** Chemistry Practical 1	2	60	50

Semester II

Theory/Practical	Credits	No. of Hours	Marks
Theory: **M3-2:** Basics in Physical, Inorganic and Organic Chemistry II	2	30	50
Practical: **M3CHP2:** Chemistry Practical 2	2	60	50

Evaluation Pattern for semester I and II:

Theory Paper

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Continuous Evaluation through: Quizzes, Class Tests, Presentations, Projects, Role Plays, Creative Writing, Assignments, etc.	As per paper pattern	1 hr.

Paper Pattern for 30 Marks:

Semester End Theory Examination:

1. Duration - These examinations shall be of **one hour** duration.
2. Theory question paper pattern:
    a. There shall be **03** questions each of **10 marks** on each unit
    b. All questions shall be compulsory with internal choice within the questions.

Question	Option	Marks	Questions Based on
Q.1	A) Objective questions 4 out of 6	04	Module I
	B) Subjective questions 2 out of 3	06	
Q.2	A) Objective questions 4 out of 6	04	Module II
	B) Subjective questions 2 out of 3	06	
Q.3	A) Objective questions 4 out of 6	04	Module III
	B) Subjective questions 2 out of 3	06	
	Total	**30**	

Evaluation Pattern for Major Practical Course

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End Semester Examination:
Viva / Assignments / Objective Question Tests (15 Marks), Overall Performance (5 Marks) = 20 Marks	One experiment (25 marks for experiment and 5 Marks for Journal = 30 Marks)	3 hr.

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Evaluation Pattern for VSC Courses

The Scheme of Examination

Internal Continuous Assessment: 40% (20 Marks)	Semester End Examination: 60% (30 Marks)	Duration for End semester examination
Viva / Assignments / Objective Question Tests (15 Marks), Overall Performance (5 Marks) = Total 20 Marks	Theory (10 Marks) and Practical (20 Marks) = Total 30 Marks	3 hr 30 minutes

Semester End Examination (30 Marks)
Duration - This examination shall be of **3 hours and 30 minutes** duration to be taken in laboratory **(1 hour for Theory and 2 hours 30 minutes for Practicals).**

Question	Option	Marks	Questions Based on
Q.1	**Based on Theory** Attempt any two out of three questions (5 marks each)	10	Unit I (Theory Component)
Q.2	**One Experiment** (15 marks for Experiment and 5 Marks for Journal = 20 Marks)	20	Unit II (Practical Component)
	Total	**30**	**---**

PRACTICAL BOOK/JOURNAL
The students are required to perform 75% of the Practical for the journal to be duly certified. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Evaluation Pattern for SEC Courses

Theory	Credit	No. of Hours	Marks
	02	30	50

Internal Continuous Assessment: 40% (20 Marks)	External, Semester End Examination Individual Passing in Internal and External Examination: 60% (30 Marks)
Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc.(at least 3)	As per the Format of Question Paper
Format of Question Paper: for the final examination	

Paper Pattern for 30 Marks

A. Semester End Theory Examination of 20 Marks

1. Duration - These examinations shall be of **one-hour** duration
2. Theory question paper pattern:
   a. There shall be **02** questions, Question 1 carries 04 Marks and Question 2 carries 16 Marks on Unit I (Theory)
   b. All questions shall be compulsory with internal choice within the questions

Question	Particulars	Marks	Questions Based on
Q.1	Objective Questions 04 out of 07	04	Unit I
Q.2	Subjective Questions 04 out of 07	16	
	Total	**20**	**---**

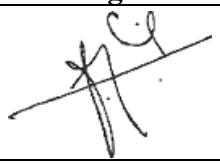
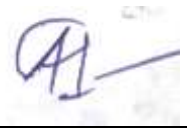
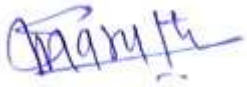
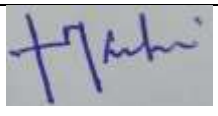
B. Semester End Practical Examination of 10 Marks

1. Duration - These examinations shall be of **One and half hour** duration
2. Give any one Experiment from Unit II for 10 Marks

Letter Grades and Grade Points:

Semester GPA/ Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result	Grading Point
9.00 - 10.00	90.0 - 100	O (Outstanding)	10
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)	9
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)	8
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)	7
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)	6
5.00 - < 5.50	50.0 - < 55.0	C (Average)	5
4.00 - < 5.00	40.0 - < 50.0	P (Pass)	4
Below 4.00	Below 40.0	F (Fail)	0
Ab (Absent)	-	Ab (Absent)	0

Signatures of Team Members

Name	Sign
Dr. Sunil Patil	
Prof. Dr. Anil Mahadeo Palve	
Dr. Aqeela A. S. Qureshi	
Ms. Farahat Khan	
Dr. Santosh Waman Kulkarni	
Dr. Rupesh Hiraman Gaikwad	
Dr. Santosh Marathe	
Dr. Uday Bamane	
Dr. Kalpana Patankar Jain	
Dr. Kiron Jathar	
Dr Nandkishor Chandan	
Dr. Aparna Milind Kulkarni	

Dr. Bhushan Langi	
Prof. (Dr.) Dinesh Vasant Bhagat	
Dr. Vishwanath R. Patil	

Appendix B

Justification for B.Sc. (Chemistry)

1.	Necessity for starting the course:	The necessity for starting the B.Sc. (Chemistry) course lies in its role as a foundational, interdisciplinary, and practical program that prepares students for higher education, diverse career opportunities, and active participation in addressing scientific and societal challenges.
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	The course has already commenced in the university and in the academic year 2023-24 it is restructured under NEP 2020
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	This course is aided / self-financed based on the sanction given by University of Mumbai to affiliated colleges time to time.
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	The duration of the program is three years (6 semesters). It is not possible to compress the course.
6.	The intake capacity of each course and no. of admissions given in the current academic year:	The intake capacity is variable from college to college based on sanctions received from the University.
7.	Opportunities of Employability / Employment available after undertaking these courses:	B.Sc. (Chemistry) graduates are versatile and can adapt their skills to various industries, making them valuable assets in the workforce. Additionally, continuous learning and staying updated on industry trends can enhance career prospects and open up new opportunities.

Sign of the
Dr. Sunil Patil
Co-ordinator,
Board of Studies in Chemistry

Sign of the
Prin. (Dr.) Madhav Rajwade
Offg. Associate Dean,
Faculty of Science and Technology

Sign of the
Prof. (Dr.) Shivram Garje
Offg. Dean,
Faculty of Science and Technology