Academic Council Meeting No. and Date :8 / September 04, 2023
Agenda Number : 2 Resolution Number : 34, 35 / 2.2, 2.23

Vidya Prasarak Mandal's
B. N. Bandodkar College of Science
(Autonomous), Thane

Syllabus for

Programme Code : BUCH

Programme : Bachelor of Science

Specific Programme : Chemistry

(Major/Minor/Generic)

[F. Y. B. Sc. Chemistry]

Level 4.5

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2023-2024

Preamble

The B.Sc. (Chemistry) programme is aimed to make the students employable and impart industry-oriented training.
The main objectives of the course are:

- To develop an aptitude to engage in continuing professional development.
- To work effectively as a part of a team to achieve a common stated goal.
- To be capable of managing complex chemical projects with consideration of the human, financial and environmental factors.
- To think analytically, creatively and critically in developing robust, extensible and highly maintainable technological solutions to simple and complex problems.
- To apply their knowledge and skills to be employed and excel in chemical industrial work.
- To communicate effectively with a range of audiences both technical and non-technical.

The syllabus is aimed to achieve the objectives. The syllabus spanning three years covers the industry relevant courses. The students will be ready for the jobs available in different fields like:

- History of Indian chemical science
- Introduction to physical concepts use for the chemical systems
- Study of thermodynamics, chemical kinetics, molecular spectroscopy, solid state, etc.
- Detailed study of periodic table
- Introduction to aliphatic and aromatic compounds
- Study of stereochemistry
- Introduction to analytical chemistry
- Study of safety precaution use in chemical laboratory
- Be skillful in handling various glassware and instruments

Prof. Dr. Anita S. Goswami-Giri
Chairperson, Bos Chemistry
VPM's B.N.Bandodkar College of Science (Autonomous), Thane

PROGRAMME OUTCOMES (POs) OF BACHELOR OF SCIENCE (B.Sc.)

The Undergraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 - Disciplinary Knowledge

Lay a strong foundation of conceptual learning in science. Instil ability to apply science in professional, social and personal life.

PO2 - Inculcation of Research Aptitude

Ignite spirit of inquiry, critical thinking, analytical skills and problem-solving approach which will help learners to grasp concepts related to research methodology and execute budding research ideas.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for curricular, co-curricular and extracurricular learning processes.

PO4 - Sensitization towards Environment

Build a cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Teamwork

Encourage learners to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 - Social and Ethical Awareness

Foster ethical principles which will help in developing rational thinking and becoming socially aware citizens. Build an attitude of unbiased, truthful actions and avoid unethical behaviour in all aspects of life.

Eligibility: Passed 12th standard (HSC) of Maharashtra State Board / CBSE / ICSE board

Duration: 3 years (Syllabus for Second Year semester I & II)

Mode of Conduct: Laboratory practicals /Offline lectures/ Online lectures

Discipline/Subject: Chemistry

Specific Programme: B.Sc. CHEMISTRY

Qualification Title: UG certificate

Discipline/Subject: Chemistry

Program Specific outcomes

1.	**PSO 1: Core Chemical Knowledge** Students will acquire a strong foundational understanding of inorganic, organic, physical, and analytical chemistry, enabling them to explain chemical principles, molecular behavior, and reaction patterns across all three years.	L2
2.	**PSO 2: Laboratory Skills & Instrumentation** Students will develop competency in classical and modern laboratory techniques, including titrimetry, chromatography, spectroscopy, and safe handling of chemicals, ensuring precise experimentation and reliable data	L3

	generation.	
3.	**PSO 3: Chemical Calculations & Data Interpretation** Students will master stoichiometric calculations, concentration units, titration curves, spectral interpretation, and other quantitative tools required for scientific reasoning and problem-solving.	L4
4.	**PSO 4: Synthetic and Analytical Problem-Solving** Students will learn to plan, execute, and troubleshoot organic and inorganic syntheses, purifications, and qualitative/quantitative analyses using logical thinking and evidence-based approaches.	L4
5.	**PSO 5: Application of Chemistry to Industry, Environment & Society** Students will understand the role of chemistry in pharmaceuticals, materials, environment, agriculture, energy, and sustainability, fostering responsible thinking and real-world application.	L5
6.	**PSO 6: Scientific Communication, Ethics & Teamwork** Students will develop skills to record, analyze, and present scientific information effectively while demonstrating integrity, safety consciousness, and collaborative behavior in laboratory and academic settings.	L6
Specific Programme: F.Y.B.Sc. (Chemistry -Major/ Minor)		

Assessment: Weightage for assessments (in percentage) For Major and Minor

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40%	60%

Curruculum Structure for the Undergraduate Degree

Programme F.Y.B.Sc Chemistry

	SEMESTER – I		
Course Code	**Major Course Title**	**No. of Lectures in hrs**	**Credits**
23BUCH1T01	Fundamental in Chemistry - I	**30**	**02**
23BUCH1T02	Fundamental in Chemistry - II	**30**	**02**
23BUCH1P01	Practicals based on 23BUCH1T01 and 23BUCH1T02	**60**	**02**
Course Code	**Skill Enhancemnet Course Title**	**No. of Lectures in hrs**	**Credits**
23BU1SEC02	Preparation of Standard Solutions and reagents	**45**	**02**
	Total	**165**	**08**
Course Code	**Minor Course Title**	**No. of Lectures in hrs**	**Credits**
23BUCH1T03	Fundamental in Chemistry - I	**30**	**02**
23BUCH1T04	Fundamental in Chemistry - II	**30**	**02**
23BUCH1P02	Practicals based on 23BUCH1T03 and 23BUCH1T04	**60**	**02**
	Total	**120**	**06**
Course Code	**Generic - Course Title**	**No. of Lectures in hrs**	**Credits**
23BUCH1T05	Indian Pioneers in Chemical Sciences and Chemistry in Everyday Life	**30**	**02**
	Total	**30**	**02**

	SEMESTER – II		
Course Code	**Major Course Title**	**No of Lectures in hrs**	**Credits**
23BUCH2T01	Physical, Inorganic and Organic Chemistry-I	**30**	**02**
23BUCH2T02	Physical, Inorganic and Organic Chemistry-II	**30**	**02**
23BUCH2P01	Practicals based on 23BUCH2T01 and 23BUCH2T02	**60**	**02**
Course Code	**Skill Enhancemnet Course Title**	**No. of Lectures in hrs**	**Credits**
23BU2SEC02	Introduction to Instrumental techniques	**45**	**02**
	Total	**165**	**08**
Course Code	**Minor Course Title**	**No. of Lectures in hrs**	**Credits**
23BUCH2T03	Physical, Inorganic and Organic Chemistry-I	**30**	**02**
23BUCH2T04	Physical, Inorganic and Organic Chemistry-II	**30**	**02**
23BUCH2P02	Practicals based on 23BUCH2T03 and 23BUCH2T04	**60**	**02**
	Total	**120**	**06**
Course Code	**Generic Course Title**	**No. of Lectures in hrs**	**Credits**
23BUCH2T05	Safety in Chemical Laboratory and Cosmetics	**30**	**02**
	Total	**30**	**02**

Semester - I

MAJOR COURSE CODE: 23BUCH1T01	(02 Credits)	No of lecture in Hrs. 30
MINOR COURSE CODE: 23BUCH1T03	(02 Credits)	No of lecture in Hrs. 30

Fundamental in Chemistry I

Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO1	Explain rate laws for various order reactions and outline the properties of liquid states such as surface tension and viscosity.	L2
CO2	Explain the properties of liquid states such as refractive index, liquid crystals and classify elements using the periodic table and describe its properties.	L2
CO3	Summarize the basic properties of atoms.	L2
CO4	Understand IUPAC nomenclature, bonding, and structure of organic compounds. .	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	1	0	0
CO 2	3	2	0	0	0	0
CO 3	3	1	0	0	0	0
CO4	3	2	0	0	0	0

Unit	Description	No. of Hours.
I	**1.1 Chemical Kinetics: (5L)** Rate of reaction, rate constant, measurement of reaction rates, order and molecularity of reaction, integrated rate equation of first and second order reactions (with equal initial concentration of reactants) (Numericals expected) Determination of order of reaction by (a) Integration method (b) Graphical method (c) Ostwald's isolation method (d) Half time method (Numericals expected) **1.2 Liquid State: (5L)** **Surface tension:** Introduction, methods of determination of surface tension by drop number method (Numericals expected)	**15**

	Viscosity: Introduction, coefficient of viscosity, relative viscosity, specific viscosity, reduced viscosity, determination of viscosity by Ostwald viscometer (Numericals expected) **Refractive index:** Introduction, molar refraction and polarizability, determination of refractive index by Abbe's refractometer (Numericals expected) **Liquid crystals:** Introduction, classification and structure of thermotropic phases (Nematic, smectic and cholesteric phases), applications of liquid crystals **1.3. Periodic Table and periodicity : (5L)** Long form of Periodic Table; Classification for elements as main group, transition and inner transition elements; **Periodicity in the following properties :** Atomic and ionic size; electron gain enthalpy; ionization enthalpy, effective nuclear charge (Slater's rule); electronegativity ; Pauling, Mulliken and Alred Rochow electronegativities (Numerical problems expected, wherever applicable.)	
II	**2.1**) **Hydrogenic atoms (5L)** **1.** Simple principles of quantum mechanics; **2.** i) Atomic orbitals ii) Shells, subshells and orbitals **3.** Many Electron Atoms **i)** Penetration and shielding **ii)** Effective nuclear charge **4.** Aufbau principle **2.2) Basics of Organic Chemistry (10L)** **2.2.1.** Classification and Nomenclature of Organic Compounds: Review of basic rules of IUPAC nomenclature. 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, carboxylic acid derivatives (acid halides, esters, anhydrides, amides), nitro compounds, nitriles and amines; including their cyclic analogues. **2.2.2** Bonding and Structure of organic compounds: Hybridization: sp3, sp2, sp hybridization of carbon and nitrogen; sp3 and sp2 hybridizations of oxygen in Organic compounds (alcohol, ether, aldehyde, ketone, carboxylic acid, ester, cyanide, amine and amide)	**15**
	Contemporary Issues: Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters **Pedagogy:** Seminar, Quiz, Debate, Group Discussion, Share Pair.	

REFERENCES	
23BUCH1T01/T03	
1.	Physical Chemistry, I. N. Levine, Tata Mc Graw Hill, 6th edition, 2010.
2.	Molecular Thermodynamics, D.A. McQuarrie, Viva Books Pvt. Ltd. New Delhi, 2004.
3.	Concise Inorganic Chemistry, J. D. Lee, ELBS, 1991.
4.	Stereochemistry of Organic Compounds Principles and Applications, D. Nasipuri, New Age International Publishers, 2nd, 2012.

MAJOR COURSE CODE: 23BUCH1T02	**(02 Credits)**	**No of lecture in Hrs. 30**
MINOR COURSE CODE: 23BUCH1T04	**(02 Credits)**	**No of lecture in Hrs. 30**
Fundamental in Chemistry II		

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO1	Understand and apply laws of thermochemistry.	L3
CO2	Understand the properties and trends of main group elements.	L2
CO3	Outline different properties of main group elements	L2
CO4	Explain the different projection formulae with their interconversion and Illustrate different types of isomerism..	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	3	2	0	1	0	0
CO 2	3	2	0	0	0	0
CO 3	3	1	0	0	0	0
CO 4	3	2	0	0	0	0

Unit	**Description**	**No. of Hours**

I	**1.1 Chemical Thermodynamics 1** Thermodynamic terms: System, surrounding, boundaries, open, closed and isolated system, intensive and extensive properties, state functions and path functions, zeroth law of thermodynamics First law of thermodynamics: concept of heat (q), work (w), internal energy (U), statement of first law, enthalpy, relation between heat capacities, sign conventions, calculations of heat (q), work (w), internal energy (U), and enthalpy (H) (Numericals expected) **1.2 Thermochemistry**: Heats of reactions, standard states, enthalpy of formation of molecules, enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Kirchhoff's equation (Numericals expected). **1.3 Comparative chemistry of Main Group Elements** Metallic and non-metallic nature, oxidation states, electronegativity, anomalous behaviour of second period elements, allotropy, catenation, diagonal relationship.	**15**
II	**2.1 Comparative chemistry of Main Group Elements** Comparative chemistry of carbides, nitrides, oxides and hydroxides of group I and group II elements. Some important compounds- $NaHCO_3$, Na_2CO_3. **2.2 Stereochemistry I:** Fischer Projection, Newman and Sawhorse Projection formulae (of erythro, threo isomers of tartaric acid and 2,3 dichlorobutane) and their interconversions; Geometrical isomerism in alkene and cycloalkanes: cis–trans and syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two similar and dissimilar chiral-centres, Distereoisomers, meso structures, racemic mixture and resolution (methods of resolution not expected). Relative and absolute configuration: D/L and R/S designations.	**15**

REFERENCES

23BUCH1T02/T04	
1.	Physical Chemistry, P.W. Atkins, Oxford University Press, 10th Edition, 2014.
2.	Stereochemistry Conformation and Mechanism, Kalsi, P. S., New Age International, 2005.
3.	Organic Chemistry, R. T. Morrison, Dorling Kindersley, 2011.

MAJOR COURSE CODE: 23BUCH1P01	(02 Credits)	No of lecture in Hrs. 60
Practicals based on 23BUCH1T01 and 23BUCH1T02		
MINOR COURSE CODE: 23BUCH1P02	**(02 Credits)**	**No of lecture in Hrs. 60**
Practicals based on 23BUCH1T03 and 23BUCH1T04		

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Estimate the unknown concentration with the help of various titrimetric analysis.	L3
CO 2	Understand principles, and techniques of gravimetric analysis and perform analysis of commercial samples.	L3
CO 3	Understand the recrystallization method.	L2
CO 4	Illustrate Thin Layer Chromatography method for separation of organic compounds	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	1	2	1
CO 2	3	2	0	2	2	1
CO 3	3	1	0	1	1	0
CO 4	3	2	0	1	2	0

1.	To prepare 0.1 N succinic acid and standardize the NaOH of two different concentrations
2.	To determine the rate constant for the hydrolysis of ester using HCl as catalyst-I (Experiment)
3.	To determine the rate constant for the hydrolysis of ester using HCl as catalyst- II (Calculation, graph and results)
4.	To determine enthalpy of dissolution of salt (like KNO_3)
5.	Commercial analysis of Mineral acid
6.	Commercial analysis of Organic acid
7.	Commercial analysis of Salt of weak acid and strong base.
8.	Titration using double indicator: analysis of solution of Na_2CO_3 and $NaHCO_3$
9.	**Gravimetric analysis:** To determine the percent purity of sample of $BaSO_4$ containing NH_4Cl
10.	**Gravimetric analysis:**

	To determine the percent purity of ZnO containing $ZnCO_3$.
11.	Purification of any four organic compounds by recrystallization selecting suitable solvent. (Provide 1g.). Learners are expected to report **a)** Solvent for recrystallization. **b)** Mass and the melting points of purified compound. (Learners should calibrate thermometer before determining melting point.) Sample -1.
12.	Sample -2
13.	Sample -3
14.	Sample -4.
15.	Chromatography Separation of a mixture of o-and p-nitrophenols by thin layer chromatography (TLC)

REFERENCES	
23BUCH1P01 and 23BUCH1P02	
1.	Senior Practical Physical Chemistry, B. D. Khosla, 2011.
2.	Vogel's *Quantitative Chemical Analysis,* J. Mendham, **Pearson, 6th edition, 2009.**
3.	Practical Organic Chemistry, F.G. Mann, Pearson Education, 2009.
4.	Textbook of Practical Organic Chemistry, A. I. Vogel. Prentice-Hall, 5th edition, 1996.

MAJOR COURSE **CODE: 23BU1SEC02**	**(02 Credits)**	**No of lecture in Hrs. 45**
SEC-Preparation of Standard Solutions and reagents		
COURSE OUTCOME		
Students will be wanted to learn OR on completion of this course, students will be able to learn:		
CO 1	Explain Accuracy, precision, calibration of glass wares and its importance.	L3
CO 2	Understand various concentration terms.	L2
CO 3	Outline the principles and importance of standard solutions.	L2
CO 4	Understand principles, types of titrimetric analysis, and theory of indicators.	L5
Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping		

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	1	2	2
CO 2	3	1	0	0	0	0
CO 3	3	1	0	0	2	0
CO 4	3	2	0	1	0	1

Unit	Description	No. of Lectures in Hours	No. of Practicals in Hours
I	**Introduction** Accuracy, precision, calibration of glass wares and its importance	**03**	**06**
II	**Chemical Calculations** Normality, Molarity, Molality, Formality, ppm, ppb, Millimoles, Milliequivalents, Mole fraction, Weight ratio, Volume ratio and weight to volume ratio.	**03**	**06**
III	**Standard solutions** Concept of Primary standard solution and Secondary standard solution	**03**	**06**
IV	**Titrimetric analysis** Types of reactions and construction of titration curves.	**03**	**06**
V	**Indicators** Theory of indicators, Preparation of indicators, Types of indicators, Mechanism of indicator action	**03**	**06**
	Total Period = 45	**15**	**30**

REFERENCES

23BU1SEC02

1.	Vogel's Textbook of Quantitative Chemical Analysis – J. Mendham et al.
2.	Fundamentals of Analytical Chemistry – Skoog, West, Holler & Crouch
3.	Quantitative Chemical Analysis – Daniel C. Harris

	Generic	Credits 02
Course code 23BUCH1T05:	**Course title – Indian Pioneers in Chemical Sciences and Chemistry in Everyday Life**	**No of lectures in hrs 30**

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Outline the general history of Indian scientists in Chemical Sciences.	L2
CO 2	Summarize the contributions of significant Indian scientists in chemical sciences and understand their field of research.	L2
CO 3	Explain the basics of food chemistry.	L2
CO 4	Summarize the methods for detecting adulterants in milk	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	1	0	0	0	2
CO 2	3	2	1	0	0	2
CO 3	3	2	0	1	0	2
CO 4	3	2	0	2	0	2

	Course: Generic – I	
Unit I	**Chemistry -I (Generic-1) Indian Pioneers in Chemical Sciences and Chemistry in Everyday Life**	**No. of Lectures**
I	**HISTORY OF SCIENCE :** General history of Chemical science **Indian Pioneers in Chemical sciences :** 1. **Prof. C. N. R. Rao:** Area of research: Prof. C. N. R. Rao is a leading Indian scientist in the field of solid state and materials chemistry. His major area of research comprises transition metal oxides and other extended inorganic solids, inorganic- organic hybrid materials, nanomaterials and generation of hydrogen by photocatalysis. 2. **Acharya P. C. Ray:** Area of research: Acharya P. C. Ray established the first modern research in Chemistry and is regarded as the father of chemical science in India. He published around 150 research articles during his lifetime. He discovered the stable compound mercurous nitrite in 1896 and established Bengal chemical and pharmaceutical works Ltd, India's first pharmaceutical company in 1901. 3. **Prof. H. J. Arniker:** Area of research: Prof. H. J. Arniker was worked in the field of Radiochemistry and Allied sciences. He was applied Neutron activation analysis in the various fields of chemical science. 4. **Har Govind Khurana:** Area of research: The researcher shared the	**15**

	1968 Nobel prize for Physiology or Medicine with Marshall W. Nirnberg and Robert W. Holley for research that showed how the order of nucleotides in nucleic acids, which carry genetic code of the cell, control the cell's synthesis of proteins. 5. **Dr. Yusuf Khwaja Hamid:** Area of research: Dr. Yusuf Khwaja Hamid is a Polish born Indian scientist, the chairman of Cipla, a generic pharmaceuticals company founded by his father Kwaja Abdul Hamied in 1935. He is also an elected fellow of the Indian National Science Academy. **6. Dr. Asima Chatterjee:** Area of research: Dr. Asima Chatterjee was an Indian organic chemist noted for her work in the fields of organic chemistry and phytomedicine. Her most notable work includes research on vinca alkaloids, the development of anti-epileptic drugs and development of anti- malarial drugs. 7. **Prof. S. R. Gadre:** Area of research: Prof. S. R. Gadre is an Indian scientist working in computational quantum and theoretical chemistry. He has authored authors over 200 publications mostly in highly impact factors.	
II	**Chemistry in Every Day Life Introduction to food chemistry** 1. Food processing and preservation: Introduction, need, chemical methods, action of chemicals (Sulphur dioxide, boric acid, sodium benzoate, acetic acid, sodium chloride and sugar) and pH control 2. Physical methods (Pasteurization: LTLT, HSST and Irradiation) 3. Detection of adulterants in Milk: Sugar, Starch, H_2O_2, Formalin, Urea, Ammonium sulphate, Detergent, Borax	**15**
	Contemporary Issues: Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters.	
	Pedagogy: Seminar, Quiz, Debate.	

REFERENCES

23BUCH1T05	
1.	Analysis of food and Beverages, George Charalanbous, Academic press, 1st edition, 1978.
2.	An Advance Dairy chemistry, P. F. Fox, P. L. H. McSweeney, Springer, Volume 3, 1997.
3.	Food Analysis: Theory and practice, Yeshajahu Pomeranz, Clifton E. Meloan, Springer, 3rd edition, 2017.
4.	Food Analysis, Edited by S. Suzanne Nielsen, Springer, 5th edition, 2017.
5.	Government of India publications of food drug cosmetic act and rules.

Semester - II

MAJOR COURSE CODE: 23BUCH2T01	CREDIT -02	NO OF LECTURES IN HRS. 30
MINOR COURSE CODE: 23BUCH2T03	CREDIT -02	NO OF LECTURES IN HRS. 30

Physical, Inorganic and Organic Chemistry-I

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Apply gas laws and kinetic theory to analyze gas behavior.	L3
CO 2	Understand thermodynamic concepts, and acid-base theories.	L2
CO 3	Explain concepts of precipitation equilibria and elimination reaction	L2
CO 4	Explain reaction of alkenes, alkynes, and conjugated systems with mechanism.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	1	0	0
CO 2	3	2	0	1	0	1
CO 3	3	2	0	0	0	0
CO 4	3	2	0	0	0	0

MAJOR COURSE CODE: 23BUCH2T01 MINOR COURSE CODE: 23BUCH2T03	CREDIT -02	NO. OF LECTURES IN HRS. 30

Unit	Description	No. of Hours.
I	**1.1 Gaseous State: (10L)** Ideal gas laws, kinetic theory of gases, Maxwell-Boltzmann's distribution of velocities (qualitative discussion), ideal gases, real gases, compressibility factor, Boyle's temperature (Numericals expected) Deviation from ideal gas laws, reasons for deviation from ideal gas laws, Van der Waals equation of state, Joule- Thomson effect: qualitative discussion and experimentation, inversion temperature. (Numericals expected) Statement of second law of thermodynamics, concepts of entropy and free energy, spontaneity and physical significance of free energy. **1.2 Acid Base Theories: (5L)** Arrhenius, Lowry- Bronsted, Lewis, Solvent – Solute concept of acids and bases, Hard and Soft acids and bases.	15
II	**2.1 Concept of Qualitative Analysis: (5L)** Precipitation equilibria, effect of common ions, uncommon ions, oxidation states, buffer action, complexing agents on precipitation of ionic compounds. (Balanced chemical equations and numerical problems expected.) **2.2Chemistry of Aliphatic Hydrocarbons** **2.2 Carbon-Carbon pi bonds: (10L)** **2.3.1 Formation of alkenes and alkynes by elimination reactions:** Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. **2.3.2 Reactions of alkenes:** Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), Mechanism of oxymercuration- demercuration, hydroboration-oxidation, ozonolysis, reduction(catalytic and chemical), syn and anti-hydroxylation (oxidation). 1, 2-and 1, 4- addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination using N- bromosuccinimide and mechanism, e.g. propene, 1- butene, toluene, ethylbenzene	15

MAJOR COURSE CODE: 23BUCH2T02	**(02 CREDITS)**	**No of lectures in hrs. 30**
MINOR COURSE CODE: 23BUCH2T04	**(02 CREDITS)**	**No of lectures in hrs. 30**

Physical, Inorganic and Organic Chemistry-II

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Understand electrolytes, ionization equilibria, pH, buffers, and the fundamentals of electromagnetic radiation.	L2
CO 2	Describe chemical bonds, analyze molecular shapes, and apply bonding theories to predict molecular geometry	L3
CO 3	Analyze Redox Chemistry and Applications, explain types of cycloalkanes and their relative stability.	L3
CO 4	Understand relative stability with energy of cyclohexane and Aromaticity.	L2

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO 1	3	2	0	1	0	1
CO 2	3	2	0	0	0	0
CO 3	3	2	0	1	0	0
CO 4	3	2	0	0	0	0

MAJOR COURSE CODE: 23BUCH2T02	(02 CREDITS)	No of lectures in hrs. 30
MINOR COURSE CODE: 23BUCH2T04	(02 CREDITS)	No of lectures in hrs. 30

Unit	Description	No. of Hours.
I	**1.1 Ionic Equilibria (5L)** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, dissociation constants of mono-, di- and triprotic acid (exact treatment for monoprotic acid) Buffers: Introduction, types of buffers, derivation of Henderson equation for acidic and basic buffers, buffer action, buffer capacity (Numericals expected) **1.2 Molecular Spectroscopy: (5L)** Electromagnetic radiation, electromagnetic spectrum, Planck's equation, interaction of electromagnetic radiation with matter: Absorption, emission, scattering, flourescence, electronic, vibrational and rotational transitions, Beer- Lambert's law (Numericals expected) **1.3 Chemical Bond and Reactivity: (5L)** 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, isoelectronic principles, applications and limitations of VSEPR theory.	15

II	**2.1 Oxidation Reduction Chemistry: (5L)** **a)** Reduction potentials **b)** Redox potentials: half reactions; balancing redox equations. **c)** Redox stability in water **i)** Latimer and Frost Diagrams **ii)** pH dependence of redox potentials. **d)** Applications of redox chemistry Redox reagents in Volumetric analysis: a) I_2; b) $KMnO_4$ **2.2 Stereochemistry-II: Cycloalkanes and Conformational Analysis: (5L)** Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy. **2.3 Aromatic Hydrocarbons: (5L)** Aromaticity: Hückel's ruleanti-aromaticity, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft alkylation/acylation with their mechanism. Hammond's postulate, Directing effects of the groups.	**15**

REFERENCES	
23BUCH2T02/23BUCH2T04	
1.	Physical Chemistry, I. N. Levine, Tata Mc Graw Hill, 6th edition, 2010.
2.	Molecular Thermodynamics, D. A. McQuarrie, Viva Books Pvt. Ltd.,New Delhi, 2004.
3.	Physical Chemistry, P.W. Atkins, Oxford University Press, 10th edition, 2014.
4.	Concise Inorganic Chemistry, J. D. Lee, ELBS, 1991.
5.	Stereochemistry Conformation and Mechanism, Kalsi, P. S, New Age International, 2005.
6.	Organic Chemistry, R. T. Morrison, Dorling Kindersley (India) Pvt Ltd. (Pearson Education) , 2011.
7.	Stereochemistry of Organic Compounds Principles and applications, D. Nasipuri, New Age International Publishers, 2nd edition, 2012.

MAJOR COURSE CODE: 23BUCH2P01	(02 CREDITS)	No of lecture in Hrs. 60
Practical based on 23BUCH2T01 and 23BUCH2T02		
MINOR COURSE CODE: 23BUCH2P02	**(02 CREDITS)**	**No of lecture in Hrs. 60**
Practical based on 23BUCH2T03 and 23BUCH2T04		

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Demonstrate experimental skills in analyzing rate constants, dissociation constants, and spectrophotometric data.	L3
CO 2	Perform semi-micro analysis to detect inorganic ions without using sulphide precipitation methods.	L3
CO 3	Apply redox titration to determine copper(II) concentration using sodium thiosulfate	L3
CO 4	Apply qualitative tests for the detection of elements in organic compounds.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	1	1	2	2
CO 2	3	2	0	2	2	2
CO 3	3	2	0	1	2	1
CO 4	3	2	0	1	1	2

Practicals

1	To determine the rate constant for the saponification reaction between ethyl acetate and NaOH.
2	To determine dissociation constant of weak acid (Ka) using Henderson's equation and the method of incomplete titration pH metrically.
3	To verify Beer-Lambert's law, using KMnO4 solution by colorimetric method.
4	To standardize commercial sample of HCl using borax and to write material safety data of the chemicals involved.
5	**Qualitative analysis: (at least 4 mixtures to be analyzed)** Semi-micro inorganic qualitative analysis of a sample containing two cations and two anions. **Cations (from amongst):** Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}, Mg^{2+}, Al^{3+}, Cr^{3+}, K^{+},NH_4+ **Anions (From amongst):** CO_3^{2-}, S^{2-}, SO^{2-}, NO_2^{-}, NO_3^{-}, Cl^{-}, Br^{3-}, I^{-}, SO_4^{2-}, PO_4^{3-}

	(Scheme of analysis should avoid use of sulphide ion in any form for precipitation / separation of cations.)
6	**Redox Titration:** To determine the percentage of copper(II) present in a given sample by titration against a standard aqueous solution of sodium thiosulfate (iodometry titration)
7	**Characterization of organic compound containing C, H, (O), N, S, X elements.** (minimum 7 compounds)

REFERENCES	
23BUCH2P01 and 23BUCH2P02	
1.	Senior Practical Physical Chemistry, B. D. Khosla, 2011.
2.	Vogel's *Quantitative Chemical Analysis,* J. Mendham, Pearson, 6th edition, 2009.
3.	Practical Organic Chemistry, F.G. Mann, Pearson Education, 2009.
4.	Textbook of Practical Organic Chemistry, A. I. Vogel, Prentice-Hall, 5th edition, 1996.

MAJOR COURSE CODE: 23BU2SEC02	(02 Credits)	No of lecture in Hrs. 15

Introduction to Instrumental techniques

COURSE OUTCOME

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Explain the Principles and Instrumentation of pH and Conductivity Measurements.	L2
CO 2	Apply pH Meter and Conductometer in Analytical Techniques.	L3
CO 3	Compare the principles, instrumentation, and applications of potentiometers, spectrophotometers, and flame emission spectrophotometers	L4
CO 4	Explain and differentiate the roles of spectrophotometry and flame emission spectrophotometry in quantitative analysis	L4

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	1	1	0	1
CO 2	3	3	1	1	2	2
CO 3	3	3	1	0	0	0
CO 4	3	3	1	0	0	1

Unit	Description	No. of Hours
I	**Instrumental techniques**	
i	**pH-meter** Principle, instrumentation and application	**02**
ii	**Conductometer** Principle, instrumentation and application	**02**
iii	**Potentiometer** Principle, instrumentation and application	**02**
iv	**Spectrophotometer** Principle, instrumentation and application	**04**
v	**Flame Emission spectrophotometer** Principle, instrumentation and application	**05**

SEC- PRACTICAL		
1	pH-meter	4
2	Conductometer	4
3	Potentiometer	6
4	Spectrophotometer	8
5	Flame Emission spectrophotometer	8
	Total	30
	Total Period = Theory + Practical (15+30 = 45)	

	Generic	Credits 02
Course code 23BUCH2T05	**Course title Safety in Chemical Laboratory and Cosmetics**	**No of lectures in hrs 30**

Students will be wanted to learn OR on completion of this course, students will be able to learn:

CO 1	Understand lab safety, PPE, and quality systems including TQM, audits, and regulatory standards.	L2
CO 2	Understand the role of accreditations and GLP in ensuring laboratory reliability and compliance.	L2
CO 3	Analyze the composition and properties of cosmetic products.	L4
CO 4	Explore formulation and sensory aspects of cosmetics.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	2	0	1	1	3
CO 2	3	2	0	0	0	3
CO 3	3	3	0	1	0	1
CO 4	3	2	0	1	1	0

	Course: Generic – II	
	Generic **Safety in Chemical Laboratory and Cosmetics**	
Unit	**Topics**	**No. of Lectures**
I	**Safety in Chemical Laboratory** Basic concepts of Safety in Laboratories, Personal Protection Equipment (PPE), OSHA, Toxic Hazard (TH) classifications, Hazardous Chemical Processes (including process calorimetry / thermal build up concepts). **Quality Management System (QMS):** Evolution and significance of Quality Management, types of quality standards for laboratories, total quality management (TQM), philosophy implementation of TQM (reference of Kaizen, Six Sigma approach & 5S), quality audits and quality reviews, responsibility of laboratory staff for quality and problems. **Accreditations:** Accreditation of Laboratories, Introduction to ISO series, Indian Government Standards (ISI, Hallmark, Agmark) **Good Laboratory Practices (GLP)** Principle, Objective, OECD guidelines, The US FDA 21CFR58, Klimisch	**15**

	score	
II	1. **Cosmetics:** Introduction and sensory properties **2. Study of cosmetic products:** 2.1 Face powder: Composition, Estimation of calcium and magnesium by complexometric titration 2.2 Lipstick: Constituents, Ash analysis for water soluble salts: borates, carbonates and zinc oxide 2.3 Deodorants and Antiperspirants: Constituents, properties Estimation of zinc by gravimetry	**15**
	Contemporary Issues: Expert lectures, YouTube Videos, Animations, NPTEL, MOOC videos, and online seminars –webinars for strengthening the subject matters	
	Pedagogy: Seminar, Quiz, Debate.	

REFERENCES

23BUCH2T05

1.	Safety and Hazards Management in Chemical Industries, M N Vyas, Atlantic Publis Ch:4, Ch:5 & Ch:19, 2020.
2.	Industrial Hygiene and Chemical Safety, M H Fulekar, IK International Pvt. Ltd., Ch:9, Ch:11 & Ch:15, 2006.
3.	Quality Management, Donna C S Summers, Pearson, 2nd, Ch:3, 2008.
4.	Quality in the Analytical Laboratory, Elizabeth Pichard, Wiley India, Ch: 5, Ch: 6 & Ch: 7, 1995.
5.	ISO 9000 Quality Systems Handbook, David Hoyle, Butterworth- Heinemann publications, Fourth Edition, Chapter: 3 & 4, 2001.
6.	Quality in Totality: A Manager‟s Guide To TQM and ISO 9000, Parag Diwan, Deep & Deep Publications, 1st Edition, 2000.
7.	OECD Principles of Good Laboratory Practice (as revised in 1997)", OECD Environmental Health and Safety Publications, OECD., 1st, 1998.
8.	A systematic approach for evaluating the quality of experimental toxicological and eco-toxicological data, Klimisch, HJ; Andreae, M; Tillmann, U, REGULATORY TOXICOLOGY AND PHARMACOL OGY 25, 1–5, (1997) ARTICLE NO. RT961076, doi:10.1006, /rtph.1996.1 076. PMID 9056496, 1997.

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

Curriculum mapping for the Undergraduate Degree Programme F.Y.B.Sc Chemistry

	SEMESTER – I	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUCH1T01	Fundamental in Chemistry I	√	--	--	--	--	--	--
23BUCH1T02	Fundamental in Chemistry II	√	--	--	--	--	--	--
23BUCH1P01	Practicals based on 23BUCH1T01 and 23BUCH1T02	√	--	√	--	--	--	--
23BU1SEC02	Preparation of Standard Solutions and reagents	√	√	√	--	--	--	√
	Minor Course Title							
23BUCH1T03	Fundamental in Chemistry I	√	--	--	--	--	--	--
23BUCH1T04	Fundamental in Chemistry II	√	--	--	--	--	--	--
23BUCH1P02	Practicals based on 23BUCH1T03 and 23BUCH1T04	√	--	√	--	--	--	√
Course Code	**Generic - Course Title**							
23BUCH1T05	Indian Pioneers in Chemical Sciences and Chemistry in Everyday Life	--	--	--	--	--	--	--
08	***Total***	**07**	**01**	**03**	**00**	**00**	**00**	**02**

	SEMESTER – II	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Major Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BUCH2T01	Physical, Inorganic and Organic Chemistry -I	√	--	--	--	--	--	-
23BUCH2T02	Physical, Inorganic and Organic Chemistry -II	√	--	--	--	--	--	--
23BUCH2P01	Practicals based on 23BUCH2T01 and 23BUCH2T02	√	--	√	--	--	--	--
23BU2SEC02	Introduction to Instrumental techniques	√	√	√	--	--	--	--
	Minor Course Title							
23BUCH2T03	Physical, Inorganic and Organic Chemistry -I	√	--	--	--	--	--	--
23BUCH2T04	Physical, Inorganic and Organic Chemistry -II	√	--	--	--	--	--	--
23BUCH2P02	Practicals based on 23BUCH2T03 and 23BUCH2T04	√	--	√	--	--	--	√
Course Code	**Generic - Course Title**							
23BUCH2T05	Safety in Chemical Laboratory and Cosmetics	-	--	--	--	--	--	--
08	***Total***	**07**	**01**	**03**	**00**	**00**	**00**	**01**

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