SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

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Learning Outcomes based Curriculum Framework

(LOCF)

For

F.Y.B.Sc. Chemistry

Undergraduate Programme

From

Academic year

2023-24

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Chemistry

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Bright O' Philip	Chairman	K J Somaiya college of science and commerce
Subject Expert nominated by Vice-Chancellor			
1	Prof. B. M. Bhanage (Inorganic chemistry)	Professor, Industrial and Engineering chemistry	ICT, Mumbai
Subject experts			
1	Prof. Kalpana Jain	Professor, and Principal	Royal College, Mumbai
2	Prof. Suresh Pawar	Professor, University department of Chemistry	University of Mumbai
3	Dr. Brijesh Singh	Head, Department of Chemistry	Jai Hind College
Representative from Industry/corporate sector/allied area			
1	Dr. Ajit Datar	Advisor	Shimadzu Analytical (I) Pvt. Ltd, Mumbai
2	Dr. P A Hasan	Scientific Officer H DIvision	BARC
Meritorious Alumnus			
1	Dr. Rajesh Rajshirke,	Senior Manager	Technology & Sourcing - Agricultural Solutions, BASF
2	Dr. Rikhil Shah	Lead, Intellectual	Avient

		Property Analyst	
3	Dr. Druman Utekar	Assistant Professor	K J Somaiya College of Engineering, Vidyavihar
Students Representative			
1	Mr. Shiv Gupta	Student	TYBSc Chemistry
2	Mr. Yash Shukla	Student	TYBSc Chemistry
3	Ms. Yogita Suvasiya	Student	SYBSc Chemistry
4	Tanishq Kumar	Student	SYBSc Chemistry
Faculty of the specialisation			
1	Dr. Pradnya. J. Prabhu	Principal	K J Somaiya college of science and commerce
2	Dr. Sugandha Shetye	Associate Professor	K J Somaiya college of science and commerce
3	Dr. Chitra Kamath	Associate Professor	K J Somaiya college of science and commerce
4	Dr. Veena Khilnani	Associate Professor	K J Somaiya college of science and commerce
5	Dr. Nishamol Kanat	Associate Professor	K J Somaiya college of science and commerce
6	Dr. Yogesh Ghalsasi	Associate Professor	K J Somaiya college of science and commerce
7	Dr. Vanita Kulkarni	Associate Professor	K J Somaiya college of science and commerce
8	Dr. Saurabh Shete	Assistant Professor	K J Somaiya college of science and commerce
9	Dr. Trupti Rane	Assistant Professor	K J Somaiya college of science and commerce

10	Dr. Rohit S. Chauhan	Assistant Professor	K J Somaiya college of science and commerce
11	Dr. Aniket Pawanoji	Assistant Professor	K J Somaiya college of science and commerce
12	Dr. Nanabhau Karanjule	Assistant Professor	K J Somaiya college of science and commerce
13	Dr. Dilip Kumar Yadav	Assistant Professor	K J Somaiya college of science and commerce
14	Dr. Afsar Ali Siddiki	Assistant Professor	K J Somaiya college of science and commerce
15	Dr. Mithun Mondal	Assistant Professor	K J Somaiya college of science and commerce
16	Mr. Jaidip Wable	Assistant Professor	K J Somaiya college of science and commerce
17	Dr. Amol Pawar	Assistant Professor	K J Somaiya college of science and commerce
18	Mrs. Meenakshi Wagh	Assistant Professor	K J Somaiya college of science and commerce
19	Mr. Sarang Gujar	Assistant Professor	K J Somaiya college of science and commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This

ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty, supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Chemistry for the long and arduous work they have put in during the compiling of the restructured syllabus.

Dr. Bright O' Philip
Chairperson
Board of Studies in Chemistry

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Preamble

Chemistry is an indispensable part of our day-to-day life. We are surrounded everywhere with chemicals and their effects on our environment. All living organisms are mainly comprised of protein, fat, carbohydrate and minerals made up of basic constituent carbon, hydrogen, nitrogen, sulphur and water. Basically, chemistry is the branch of science which deals with study of matter, their properties and the energy changes involved during any process. Chemical technologies enrich our quality of life by providing new solutions to problems in health, material energy usage. Hence study of Chemistry prepares the student to meet challenges of the future.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit bank and creating a National research Foundation to promote and support research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender

or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to develop an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. Our focus is to involve young minds to participate, contribute and add value at each stage in the field of their study. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum in multiple folds.

The LOCF will certainly help teachers to envisage the outcome expected from the learners at the end of the programme. For students, it will be a guide which shows how this curriculum will help them acquire all the skills and knowledge which are essential in their personal and academic growth. Higher education qualifications such as Bachelor's Degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

1. Introduction

The B.Sc. Chemistry programme is developed by keeping in mind interest of learners to explore the field of chemistry. The framework helps to maintain the standard of chemistry degrees/programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The BSc programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students learning levels.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intents to empower graduates with the skills required for pursuing Chemistry-related careers, higher education in Chemistry and allied subjects.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world;

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Chemistry. It covers the basic concepts of Chemistry to establish a strong foundation of the subject and helps students to explore the subject more. Topics varying from synthetic organic chemistry, stereochemistry, spectroscopy, environmental chemistry, polymers, coordination

chemistry, bio-organic chemistry, physical chemistry, analytical chemistry, group theory & its applications, quantum mechanics etc are taught. Chemical industry, Renewable and non-renewable sources of organic compounds, Green chemistry and Nanochemistry are taught as choice-based core course in semester III and IV. Business skills for chemist, Gas and liquid chromatography, Chemistry of cosmetics and Dairy chemistry are taught as skill enhancement course in semester V and VI respectively.

The practical sessions will help the students to gain sufficient skills in chemical analysis, preparations, solvent extraction, chromatography, as well as quantitative analysis. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work in the curriculum ensures team building attitude within students and utilise every aspect of the team members in the success of any project. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the everchanging needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Chemistry will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of B.Sc. Chemistry

Degree programme in Chemistry is designed to include cutting edge and core topics from Physical, Inorganic, Organic and Analytical chemistry in a perfect balance. The scope of individual topics varies with the nature of specific chemistry branch. In our endeavour to improve the employability of graduates of chemistry programme, the curriculum offers courses on business skills in chemistry and food/cosmetic analysis. The B.Sc. chemistry programme is of three years duration. Each year is divided into two semesters. The total numbers of semester are six. The

teaching and learning in the B.Sc. chemistry programme will involve theory classes (lectures) and practical.

The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and when required. Wherever possible RBPT approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of bachelor's degree programme in chemistry are to:

1. Create a great learning environment for students to inculcate deep interests in chemistry.
2. Provide choice-based learning to students.
3. Empower students by providing appropriate tools of analysis to address issues and problems in the field of chemistry
4. Help students to develop the ability to use their knowledge and skills to handle the specific theoretical and applied problems in chemistry
5. Encourage students to pursue advanced studies related to chemistry by creating a strong and profound base of fundamental concepts.
6. Assist students to develop an array of generic skills which are helpful in creating employment and business opportunities.

3. Graduate Attributes in chemistry

Attributes expected from the graduates of B.Sc. Chemistry Programme are:

GA 1: Comprehensive knowledge and understanding of various concepts and theoretical principles in the field of chemistry and its different sub-fields.

GA 2: Information of safe handling of chemicals and role of chemistry while addressing environmental issues

GA 3: Proficiency in qualitative and quantitative laboratory techniques

GA 4: Ability to construct a research problem and communicate the results of scientific work in oral, written and e- formats.

GA 5: Sense of critical thinking and problem-solving skills in theoretical and applied chemistry.

GA 6: Enthusiasm for working individually and in diverse teams through interdisciplinary projects

GA 7: Respect for professional ethics and responsibilities of the chemical science practice

GA 8: Knowledge of subject-related and transferable skills that are relevant to chemistry related job trades and employment opportunities

4. Qualification descriptors

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entry and exit points and re-entry options, with appropriate certifications such as:

- a UG certificate is awarded to students who opt to exit after completing 1 year (2 semesters) of study in the chosen fields of study with having secured 44 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
- a UG diploma is awarded to students who opt to exit after 2 years (4 semesters) of study with having secured 88 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
- a bachelor's degree is awarded after a 3-year (6 semesters) programme of study in major discipline with having secured 132 credits and minimum credit requirements as follows

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	48
2	Minor Stream Course	20
3	Discipline Specific Elective Course	06
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04

7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	20
10	Open Elective Course	10
Total		132

- After completing the requirements of three year Bachelor's degree, candidate who meet the minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of undergraduate program to pursue and complete Bachelor's degree with honours/research (subject to change).
- a 4-year bachelor's degree (honours) is awarded after eight semesters programme of study with having secured 176 credits and minimum credit requirements as follows:

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	76
2	Minor Stream Course	24
3	Discipline Specific Elective Course	14
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	24
10	Open Elective Course	10
Total		176

- They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree with Research.

The 4-year bachelor's degree programme is considered a preferred option since it would provide the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

Upon successful completion of the programme, students receive B.Sc. degree in the Chemistry. B.Sc. Chemistry graduates of this department are expected to demonstrate the extensive knowledge of various concepts of chemistry and its application thus contribute in research, development, teaching, government and public sectors. This programme will establish a foundation for student to further pursue higher studies in chemistry. The list below provides a synoptic overview of possible employment areas provided by an undergraduate training in chemistry.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training in Chemistry:

1. Academics
2. Research
3. Pharmaceutical company
4. Chemical Industry
5. Polymer Industry
6. Agrochemical Industry
7. Forensic science department
8. Oil and gas sectors

9. Cosmetic industry
10. Paints and dyes
11. Energy
12. Petrochemical Industry
13. Environmental monitoring and analysis
14. Packaging technology

Job Roles for B.Sc. Chemistry graduate:

After graduation one can seek a professional career as:

1. Lab chemist
2. R & D Chemist
3. Production officer
4. Quality control chemist
5. Academist
6. Environment analyst
7. Project fellow
8. Entrepreneur
9. Civil services
10. Competitive exams

Higher Education options for B.Sc. chemistry graduate:

1. M.Sc. in general chemistry/analytical chemistry/organic chemistry/physical chemistry/Drug chemistry/ Pharmaceutical chemistry/Environment chemistry/Polymer chemistry
2. Integrated M.Sc.-Ph.D. in Chemistry
3. PG Diploma in advance instrumental analysis/drug design/Intellectual Property rights/ Clinical research, etc

4. Courses in management
5. B.Ed

The learners who complete three years of full-time study of an undergraduate programme of study will be awarded a Bachelor's degree in chemistry.

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of B.Sc. Chemistry, the learner will be able to:

PSO I: Discuss the fundamental concepts in Physical, Inorganic, Organic and Analytical Chemistry.

PSO II: Relate Cutting-edge Knowledge acquired in different fields of chemistry such as mechanisms of organic and inorganic reactions, thermodynamics, Nanoscience, and Nuclear Chemistry to develop state of the art technologies for improving the quality of life.

PSO III: Use analytical skills, problem solving skills requiring applications of chemical principles.

PSO IV: Synthesize, separate and characterize compounds using laboratory and instrumentation techniques.

PSO V: Apply good laboratory practices and safety principles and create awareness about environmental issues.

PSO VI: Justify the central role of chemistry in society and have preparedness in lifelong learning of technological change.

5.1 Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI
I	MJ I	√	√	√		√	√
	MJ II	√	√	√	√	√	√
	MN I						
	MN II						
	AEC I						
	AEC II						
	VEC						
	CC						
	OE						
II	MJ I	√	√	√			√
	MJ II	√	√	√	√	√	√
	MN I						
	MN II						
	AEC I						
	AEC II						
	VEC						
	IK						
	CC						
	OE						

6. Structure of B.Sc. chemistry programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years UG having six semesters (two semesters per year) or four years UG (Honours) having eight semesters (two semesters per year). Credit Distribution for Eight Semester is as follows:

Semester	MJ	DSE	SEC	VSC	MN	AEC	VEC	IKS	CC	FP	INT/ APT	OE	Total
I	6	-	-	-	6	4	2	-	2	-	-	2	22
II	6	-	-	-	6	3	2	1	2	-	-	2	22
III	6	-	3	2	4	1	-	1	2	-	-	3	22
IV	6	-	3	2	4	-	-	-	2	2	-	3	22
V	12	-	-	-	-	-	-	-	-	2	8	-	22
VI	12	6	-	4	-	-	-	-	-	-	-	-	22

BSc with Honours – 22 credits in Sem VII and VIII

BSc with Research – 22 credits in Sem VII and VIII

To acquire a degree in B.Sc. chemistry a learner must study

1. **Major Core Courses (MJ):**

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year.

c) There are twenty four Major Core courses (MJ), two each, in semesters I to IV; and four each in semesters V and VIII.

d) Each Major Core Courses is compulsory.

e) Each Major Core Course from semester I to VI is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

f) Each Major Core Course from semester VII and VIII is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit for practical of three hours per week in every semester.

g) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. Minor Stream Course (MN):

a) A course is chosen by a candidate from interdisciplinary stream as a minor course. Minor Stream course helps a student to gain a broader understanding beyond the major discipline.

b) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

c) Students may declare the choice of the minor stream course at the end of the second semester after exploring various courses.

d) There are two each Minor stream course (MN), in semesters I and II. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

e) There is one each Minor stream course (MN) in semester III and IV. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 2 credits for practical of four hours per week in every semester.

f) Each Minor stream Courses is compulsory.

3. Ability Enhancement Courses (AEC)

a) The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

b) Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills.

c) There are five AE courses in spread over three semesters (I to III).

d) Each student is supposed to take two AE in semester I - English language and Modern Indian language of 2 credits each.

e) There are two AE in semester 2 - English language of two credits and Modern Indian language of 1 credit.

f) There is one AE in semester 3 - Modern Indian language of 1 credit.

4. Value Education Courses (VEC)

a) The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living.

b) The VEC courses offered are:

VEC 1- Environmental Science I (2 credits) (Semester I),

VEC II- Environmental Science II (2 credits) (Semester II).

5. Co-Curricular courses (CC):

a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.
b) The main purpose of these courses is to provide life skills in hands-on mode to increase employability.
c) There are two CC each in semester I to III – NCC (compulsory 1 credit course) and Other one from Music/Sports training program/Yoga/ Study Circle
d) There are three CC each in semester IV – NCC (compulsory 1 credit course), second one from Music/Sports training program/Yoga/ Study Circle of 1 credit and third one is Field project of 2 credits.

6. Open Elective (OE)

a) They are designed to provide multidisciplinary education.
b) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester I and II of two credit each.
c) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester III and IV of three credit each.
d) Open courses are offered in cognate disciplines by different departments in the college.

7. Indian Knowledge System (IKS)

a) They are designed to recognizes the rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle.
b) Students can opt for one General IKS in semester II – Indian cultural Heritage of one credit.
c) There is one IKS based on major subject in semester III of 1 credit.

8. Skill Enhancement Course (SEC):

a) They are designed to provide skill-based knowledge pertaining to the Major course to the learner.
b) The main purpose of these courses is to provide life skills in hands on mode to increase employability.
c) There are Two skill enhancement courses offered. Each student is supposed to take one SEC in each semester III and IV of 3 credit each (2 credit theory and 1 credit practical).

9. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the major course subject of study.
b) There are two discipline specific elective courses (DSE), offered in semesters VI of 2 credits theory and 1 credit practical.
c) There is one discipline specific elective course (DSE), offered in semesters VII and VIII each of 2 credits theory and 2 credit practical.
d) There is one advance level disciplinary course – Research Methodology of 4 credits offered in semester VII.

10. Vocational Skill Course (VSC)

a) Vocational courses are designed to provide practical, hands-on training, competencies, and proficiency to students, ultimately enhancing their skills and employability.
b) These courses are tailored to prepare individuals for specific careers and industries.
c) There are two VSC offered one each in semester III to IV, each one is of two credts.
d) There is one VSC offered in semester VI of 4 credits.

II. On Job Training (OJT)

a) On Job training of 4 credits is offered in semester VIII to enhance the specific skills and competencies required for a particular job
b) OJT bridges the gap between theory and practical application, promoting a deeper understanding of concepts.

Internship/ Apprenticeship have a prominent role in linking higher education with the requirements of industry and the world of work. Students are offered internship/ apprenticeship embedded degree program to fulfil the objective of improving employability and forming robust industry academia linkage.
Internship/Apprenticeship of 8 credits is offered in semester V.

Field based learning /project will provide opportunities for students to understand the different socio-economic contexts. It aims at giving the students exposure to development related issues in rural and urban settings.

Two field projects each 2 credits are offered one in each semester IV and V

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
1	I	MJ I	23USICHMJIFPAI	Fundamentals of Physical and Analytical Chemistry I
2		MJ II	23USICHMJ2FOII	Fundamentals of Organic and Inorganic chemistry I
3		MJ P	23USICHMJP	Based on MJ I and MJ II
4		MN I		Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology
5		MN II		Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology
6		MN P		Based on MN I and MN II
7		AEC I		Communication in English Level I
8		AEC II		Modern Indian Language Level I (Hindi/Marathi)
9		VEC		Environmental Science I
10		CC I		NCC
11		CC II		Music/Yoga/Sports Training Program Level I/ Study Circle

12		OE		Social Media Advertising/ Introduction to microeconomics
13	II	MJ I	23US2CHMJIFPA2	Fundamentals of Physical and Analytical Chemistry II
14		MJ II	23US2CHMJ2FOI2	Fundamentals of Organic and Inorganic chemistry II
15		MJ P	23US2CHMJP	Based on MJ I and MJ II
16		MN I		Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology
17		MN II		Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology
18		MN P		Based on MN I and MN II
19		AEC I		Communication in English Level II
20		AEC II		Modern Indian Language Level II (Hindi/Marathi)
21		VEC		Environmental Science - II
22		IK		Indian Cultural Heritage
23		CC I		NCC
24		CC II		Music/Yoga/Sports Training

				Program Level 1/ Study Circle
25		OE		Indian Finance system and budget/ Brand Management

6.2 Credit distribution for B.Sc. Chemistry

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	MJ I	Fundamentals of Physical and Analytical Chemistry I	2	1	3
	MJ II	Fundamentals of Organic and Inorganic chemistry I	2	1	3
	MN I	Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	2	1	3
	MN II	Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	2	1	3
	AEC I	Communication in English Level I	2		2
	AEC I	Modern Indian Language Level I	2		2
	VEC	Environmental Science I	2		2
	CC I		1		1
	CC II		1		1
	OE		2		2
	Total				**22**
II	MJ I	Fundamentals of Physical and Analytical Chemistry II	2	1	3
	MJ II	Fundamentals of Organic	2	1	3

		and Inorganic chemistry II			
	MN I	Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	2	1	3
	MN II	Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	2	1	3
	AEC I	Communication in English Level II	2		2
	AEC II	Modern Indian Language Level II	1		1
	VEC	Environmental Science - II	2		2
	IKS	Indian Cultural Heritage	1		1
	CC I		1		1
	CC II		1		1
	OE		2		2
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	Minor Stream Courses (MN)	Ability Enhancement Courses (AEC)	Value Education Course (VEC)	Indian Knowledge System (IKS)	Co-Curricular Course (CC)	Open Elective (OE)
I	I]MJI Fundamentals of Physical and Analytical Chemistry I 2] MJ II Fundamentals of Organic and Inorganic chemistry I	I] MN I Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology 2] MN II Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	I] AEC I Communication in English Level I 2] AEC II Modern Indian Language Level I	Environment Science I	-	I] NCC II] Music/ Yoga/ Sports Training Program Level I/ Study Circle	Social Media Advertising/ Introduction to microeconomics
II	I] MJ I Fundamentals of Physical and Analytical Chemistry II	I] MN I Course from Biochemistry/ Physics/ Mathematics/ Physics/	I] AEC I Communication in English Level II 2] AEC II	Environment Science II	Indian Cultural Heritage	I] NCC II] Music/ Yoga/ Sports Training Program Level I/ Study Circle	Indian Finance system and budget/ Brand Management

	2] MJ II Fundamentals of Organic and Inorganic chemistry II	Microbiology/ Botany/ Zoology/ Geology 2] MN II Course from Biochemistry/ Physics/ Mathematics/ Physics/ Microbiology/ Botany/ Zoology/ Geology	Modern Indian Language Level II				

6.4 Course Learning Objectives

The three-year undergraduate Chemistry programme is designed to familiarize students with significant developments in Chemistry. The objective of structured syllabus in Chemistry is to make the concepts and basics of Chemistry clear and interesting to students and also to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Chemistry.

7. Detailed B.Sc. Chemistry Syllabus

F. Y. B.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus - F. Y. B.Sc. Chemistry

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER I									
Major Core courses THEORY									
I	Fundamentals of Physical and Analytical Chemistry I	23USICHMJIFPAI	2	30	2	15	20	30	50
II	Fundamentals of Organic and Inorganic chemistry I	23USICHMJ2FOII	2	30	2	15	20	30	50
Core courses PRACTICAL									
		23USICHMJP	2	60			CIA		50
SEMESTER II									
Major Core courses THEORY									
I	Fundamentals of Physical and Analytical Chemistry II	23US2CHMJ1FPA2	2	30	2	15	20	30	50
II	Fundamentals of Organic and Inorganic chemistry II	23US2CHMJ2FOI2	2	30	2	15	20	30	50
Core courses PRACTICAL									
		23US2CHMJP	2	60			CIA		50

F.Y. B. Sc. (CHEMISTRY) SEMESTER I

Major Core Course- I

COURSE TITLE: Fundamentals of Physical and Analytical Chemistry I

COURSE CODE: 23USICHMJIFPAI [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Demonstrate the fundamental principles of thermochemistry and ionic equilibrium. 2. Illustrate the various concepts involved in the qualitative and quantitative chemical analysis.

Module 1	Thermochemistry and ionic equilibrium	[15L]

Learning Objectives:

The module is intended to

1. Revise basic terminology of Thermodynamics
2. Use of first law to calculate enthalpy changes accompanying different chemical reactions
3. Illustrate the application of Thermochemistry for different chemical transformations
4. Discuss the concept of entropy as unavailable energy, its physical significance and second law of thermodynamics
5. Describe use of second law to determine efficiency of heat engines and quantitative estimation of absolute entropy using third law of thermodynamics
6. Discuss the concept of electrolytes, its type
7. Explain the dissociation/ionisation and degree of ionisation
8. Acquire knowledge for acid-base theories, relative strength of acid and bases, Ostwald's dilution law
9. Describe the core concepts of common ion effect and solubility products.

10. Illustrate the salt, its types and salt hydrolysis, buffer, its action, Henderson-Hasselbach equation and significance 11. Solve the numerical based on pH of acid & bases, solubility product, degree of dissociation, dissociation constant, buffer pH		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Use of first law of thermodynamics to solve work - energy problems for chemical processes. 2. Write balanced thermochemical equation for different chemical reactions 3. Use of Hess law to determine different enthalpies of reactions. 4. Differentiate between spontaneous and non-spontaneous processes and calculations of entropy of different substances 5. Explain the fundamentals of conductors such as electrolyte and metal conductor, types of electrolytes. 6. Describe the concept of acid & base, degree of dissociation, Ostwald's dilution law, ionic product of water, pH scale. 7. Discuss the concept of common ion effect, Solubility & solubility product. 8. Illustrate the concept of buffer, its mechanism, Henderson equation, salt and its hydrolysis. 9. Predict the strength of electrolytes and differentiate acid-bases 10. Apply the basic knowledge of ionic equilibrium to solve the numerical based on pH of acid & bases, solubility product, degree of dissociation, dissociation constant, buffer pH		
1.1	**Thermochemistry**	[7L]
	Recapitulation of important terms of thermodynamics- state functions, path function, internal energy, enthalpy, work, heat, maximum work, first law of thermodynamics	[2L]

	Important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, applications of Hess's law, integral and differential enthalpies of solution and dilution, Kirchhoff's equation, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, variation of enthalpy of a reaction with temperature (Numerical expected).	[5L]
1.2	**Ionic equilibrium**	[8L]
1.2.1	Electrolytes and nonelectrolytes: Electrolytes and non-electrolytes, types of electrolytes (weak and strong), dissociation, degree of dissociation, factors affecting degree of dissociation, Oswald's dilution law, dissociation constants of acids and bases, relative strength of acid and bases, ionic product of water, concept of acid and base: Arrhenius theory, Bronsted-Lowery theory, Lewis theory, pH scale.	[4L]
1.2.2	Buffers: Types of buffers, buffer capacity, mechanism of buffer action, Henderson Hasselbach equation and its significance (Numericals expected).	[2L]
1.2.3	Concept of salt: Types of salts, solubility, solubility products and its applications, common ion effect and its applications	[2L]

References:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).

- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Module 2	Introduction to analytical methods and concept of quality	[15L]

Learning Objectives:

This module is intended to:

1. Discuss concept of chemical analysis, its classification and applications
2. Distinguish between quantitative and qualitative analysis
3. Elaborate the theory of elemental analysis of organic compounds
4. Describe the core concepts of common ion effect and solubility products in semi-micro inorganic separation, complexation and oxidation number
5. Explain calibration of glassware
6. Solve the numerical based on mole concept, mole fraction, equivalent weight of acid, base, salt, reducing agent and oxidising agent, molarity, molality, normality, ppm and ppb
7. Discuss the concept of quality

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Describe the basic concept of chemical analysis.
2. Elaborate the concept of common ion effect, Solubility & solubility product, oxidation number, complexation, indicator theory.
3. Differentiate classical method and instrumental methods
4. Apply the basic knowledge of chemical calculation to solve the numerical based on mole concept, mole fraction, equivalent weight of acid, base, salt, reducing agent and oxidising agent, molarity, molality, normality, ppm and ppb

2.1	**Analytical methods:**	[4L]
	Types of analytical methods (depending on sample size, sample information, sample properties), classification	

	(classical and instrumentation), process of analysis, qualitative & quantitative analysis - types, examples, applications	
2.2	**Qualitative analysis and mole concept**	
2.2.1	Qualitative analysis: Theory of elemental analysis of organic compounds, theoretical concepts in semi-micro analysis of inorganic mixture (common ion effect, solubility product, complexation and oxidation number). Standard solution-primary and secondary standards, preparation of standard solutions, standardization, calibration of glasswares.	[4L]
2.2.2	Mole concept: Methods of expressing concentrations of solutions, molarity, formality, normality, mole fraction, molality, ppm, ppb, ppt, milli equivalents, millimoles, dilution of solutions.	[4L]
2.3	**Concept of quality:**	[3L]
	General idea, quality control and quality assurance, important quality parameters like accuracy, precision, range, limit of detection and limit of quantification, concept of errors	

References:

- A I Vogel. Inorganic quantitative analysis, 6th edition.
- Skoog, Fundamentals of Analytical Chemistry 9th edition.
- Gary Christian, Analytical Chemistry 6th edition.

Question paper Template

F.Y. B. Sc. (CHEMISTRY) SEMESTER I

Major Core Course- I

COURSE TITLE: Fundamentals of Physical and Analytical Chemistry I

COURSE CODE: 23USICHMJIFPAI [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	10	10	-	-	-	25
Total marks per objective	10	20	20	-	-	-	50
% Weightage	20	40	40	-	-	-	100

F.Y. B. Sc. (CHEMISTRY) SEMESTER I

Major Core Course- II

COURSE TITLE: Fundamentals of Organic and Inorganic chemistry I

COURSE CODE: 23USICHMJ2FOI1 [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Apply IUPAC nomenclature rules to aliphatic as well as aromatic compounds and relate the fundamentals of organic chemistry with stability, reactivity, structure of organic compounds. 2. Illustrate the various theories of chemical bonding for predicting structures of the molecules.		
Module 1	IUPAC nomenclature of organic compounds and introduction to organic chemistry	[15L]
Learning Objectives: The module is intended to 1. Discuss types of Cleavage of bonds 2. Classify Nucleophile and electrophile. 3. acquire basic knowledge of reactive intermediates and mechanism of organic reactions 4. Describe the core concepts of organic chemistry i.e. resonance, hyperconjugation, inductive effect etc. and their application		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Discuss the fundamental principles of organic chemistry and predict outcomes and derive mechanisms of various types of organic reactions. 2. Illustrate various types of reactive intermediates and factors affecting their stability 3. Assign the IUPAC nomenclature of aliphatic and aromatic compounds.		

1.1	**IUPAC nomenclature of Organic compounds:**	[8L]
	• Types of organic compounds. Nomenclature of aliphatic compounds (Mono-functional) • Priority rules • Nomenclature of bifunctional compounds. • Nomenclature of benzene derivatives, mono, di and polysubstituted derivatives.	
1.2	**Introduction to organic chemistry**	[7L]
	• Cleavage of Bonds: Homolysis and Heterolysis. • Reactive Intermediates: Carbocations, Carbanions and free radicals' generations and its reactivity • Structure, shape and reactivity of organic molecules: Nucleophiles and Electrophiles. • Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. • Types of organic reactions based on mechanism - substitution, addition, elimination and rearrangement	

References:

- Organic Chemistry, Morrison Boyd & Bhattacharjee, edition 7th, 2012- Pearson India
- A Logical Approach to Modern Organic Chemistry, Jagdamba Singh, Pragati Prakashan
- A Textbook of Organic Chemistry by Bahl Arun, Bahl B.S., 22nd edition, Chand publications.

Module 2	Chemical bonding	[15L]

Learning Objectives:

This module is intended to:

1. Discuss types of chemical bonding.
2. Describe the energy change involved in formation of various molecules.
3. Acquire basic knowledge of various theories regarding bonding.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Discuss the fundamentals of various types of chemical bonding.
2. Describe the basic concept of various theories for chemical bonding.
3. Illustrate the application of various theories for the formation of different molecules.

2.1	Chemical bond, Octet rule, ionic bond, formation of ionic bond, energy changes in the formation of ionic bond, characteristics of ionic compound, lattice energy, solvation energy, Born-Haber cycle, Born Lande's equation and Kapustinskii equation	[4L]
2.2	Covalent bond, formation of covalent bond, energy changes in the formation of covalent bond, characteristics of covalent compound, electron dot structure, Valence bond theory (VBT): postulates of valence bond theory, sigma and pi bonds, coordinate covalent bond	[3L]
3.3	Hybridization: Concept of hybridization, types of hybridization - sp, sp^2, sp^3 with respect to inorganic molecules like $BeCl_2$, BF_3, $SiCl_4$ and organic molecules like ethane, ethene and ethyne. Valence shell electron pair repulsion (VSEPR) theory:	[8L]

	Postulates of VSEPR theory, Shape of chemical species on the basis of VSEPR theory - NH_3, ClF_3, BrF_5, PX_3, ICl_2^- and TeF_5^-	

References:

- Fundamental concepts of Inorganic Chemistry, Asim K Das, Volume 2, 2nd edition.
- Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 6th edition.
- Selected topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand Publications, Revised edition.
- A Textbook of inorganic chemistry, Anilkumar De

Question Paper Template

F.Y. B. Sc. (CHEMISTRY) SEMESTER I

Major Core Course- II

COURSE TITLE: Fundamentals of Organic and Inorganic chemistry I

COURSE CODE: 23USICHMJ2FOII [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	10	5	-	-	25
II	5	15	5	-	-	-	25
Total marks per objective	10	25	15	5	-	-	50
% Weightage	20	50	20	10		-	100

F. Y. B. Sc. (CHEMISTRY)

SEMESTER I - Practical

COURSE CODE: 23USICHMJP Credit- 02

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Illustrate the importance of calibration of volumetric apparatus. 2. Apply the principles of volumetric analysis to carry out titrations. 3. Evaluate the elemental analysis of organic compounds.
Learning Objectives: The Practical is intended to 1. Discuss the importance of calibration of volumetric apparatus 2. Explain the fundamental mole concept 3. Standardise the solution by volumetric analysis 4. Discuss elemental analysis of organic Compounds
Learning Outcomes: After the successful completion of the practical, the learner will be able to: 1. Calibrate the apparatus for volumetric analysis 2. Prepare standard solutions and estimate the concentration of given solution 3. Identify unknown organic compounds by using qualitative analysis (Organic spotting).
Major Core Course I: Calibration of apparatus and Volumetric Estimation
1. Calibration of pipettes and standard flasks.

2. Standardization of NaOH by titrating it with succinic acid solution.
3. Standardization of $KMnO_4$ by titrating it with oxalic acid solution.
4. Estimation of sodium carbonate & sodium bicarbonate present in a mixture.
5. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ solution.

Major Core Course II	Organic Spotting

Identification of organic compounds (Minimum 8)

References:

- Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

F.Y. B. Sc. (CHEMISTRY) SEMESTER II

Major Core Course- I

COURSE TITLE: Fundamentals of Physical and Analytical Chemistry II

COURSE CODE: 23US2CHMJIFPA2 [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Illustrate the physical properties of gases and liquids, as well as the practical applications of surface tension and viscosity measurements in chemical analysis and experimentation. 2. Discuss the concepts of acid-base and redox titrations, as well as gravimetric analysis techniques.

Module 1	Gaseous and Liquid States	[15L]

Learning Objectives:

The module is intended to

1. Discuss the causes of Deviation of real gases from ideal behaviour and compressibility factor.
2. Derive Van Der Waals equation of State applicable to real gases.
3. Describe critical Conditions for Liquefaction of gases.
4. Illustrate two important Properties of liquids -Surface Tension and Viscosity.
5. Discuss experimental measurement and applications of Surface Tension and Viscosity.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Explain the behaviour of real gases using van der waals equation of state.
2. Discuss the critical conditions for liquefaction of real gases.

3. Solve different numerical based on the compressibility factor, critical constants, surface tension and viscosity measurements.		
1.1	**Gaseous state:** Behaviour of real gases: deviations from ideal gas behaviour, Boyle temperature, compressibility factor (Z) and its variation with pressure for different gases, causes of deviation from ideal behaviour, volume correction and pressure correction, van der Waals equation-derivation and application in explaining real gas behaviour.	[5L]
1.2	**Liquefaction of gases:** Effect of temperature on liquefaction of gases-Andrews isotherms, importance of critical constants, relation between critical constants and van der Waals constants, Joule Thomson effect and inversion temperature, Linde's experiment for liquefaction of gases.	[5L]
1.3	**Liquid state:** Introduction, surface tension: determination of surface tension by drop number method using Stalagmometer, types of surfactants and micelle formation, applications of surface-active agents in treatment of oil spills and detergent action, viscosity: introduction, coefficient of viscosity, determination of coefficient of viscosity by Ostwald viscometer, applications of viscosity measurement- viscosity of motor oils, lubricants (Numerical on surface tension and viscosity measurements are expected).	[5L]

References:

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).

Module 2	Volumetric and gravimetric analysis	[15L]

Learning Objectives:

This module is intended to:

1. Explain volumetric analysis, its classification, basic theory and techniques, indicator theory, calibration of glassware
2. Discuss gravimetric analysis, its type, basic principle of indirect method & its technique.

Learning Outcomes:

After the successful completion of the module, the learner will be able to explain the classical method of chemical analysis such as volumetric and gravimetric analysis, its basic principle and techniques with suitable examples.

2.1	**Volumetry**	
2.1.1	**Acid-base titration**: Theory, types and examples, classical and instrumental methods, pH-metry and titration curves for i) strong acid v/s strong base ii) weak acid v/s strong base iii) weak base v/s strong acid iv) weak acid v/s weak base (Numericals expected).	[6L]
2.1.2	**Redox titrations**: Theory, examples of oxidising and reducing agents, examples of different redox	[6L]

	titrations systems, titration curves for redox titration of i) Fe^{2+} against Cr^{6+} ii) Fe^{2+} against Ce^{4+} (Numericals expected). Types of indicators, theory of acid-base and redox indicators.	
2.2	**Gravimetry**	
	Types of gravimetric analysis (direct and indirect analysis), basic principle and steps involved in direct gravimetric analysis, factors affecting precipitation and mechanism of precipitation	[3L]
References: • A I Vogel. Inorganic quantitative analysis, 6th edition. • Skoog, Fundamentals of Analytical Chemistry 9th edition. • Gary Christian, Analytical Chemistry 6th edition.		

Question Paper Template

F.Y. B. Sc. (CHEMISTRY) SEMESTER II

Major Core Course- I

COURSE TITLE: Fundamentals of Physical and Analytical Chemistry II

COURSE CODE: 23US2CHMJIFPA2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	10	10	-	-	-	25
Total marks per objective	10	20	20	-	-	-	50

% Weightage	20	40	40	-	-	-	100

F.Y. B. Sc. (CHEMISTRY) SEMESTER II

Major Core Course- II

COURSE TITLE: Fundamentals of Organic and Inorganic chemistry II

COURSE CODE: 23US2CHMJ2FOI2 [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Illustrate the methods of preparation, properties and reactions of aliphatic hydrocarbons and haloalkanes. 2. Compare the trends in the periodic table and properties of the elements.		
Module 1	**Chemistry of hydrocarbons and haloalkanes**	**[15L]**
Learning Objectives: The module is intended to 1. Define and identify alkane, alkene, alkyne, alkyl halide. 2. List some properties and applications of hydrocarbons and haloalkanes. 3. Discuss the synthesis and characteristic reactions of hydrocarbons and haloalkanes.		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Discuss basic practical skills for synthesis of hydrocarbons and haloalkanes. 2. Predict the reactivity of hydrocarbons and haloalkanes from their structure 3. Write mechanistic aspects of these reactions and illustrate their application in multi-step synthesis		
1.1	Alkane	[4L]

	Natural resources and applications, methods of formation: Kolbe reaction, Wurtz reaction, decarboxylation of carboxylic acids; hydrogenation of alkenes and hydrolysis of Grignard reagent reactions: halogenation of alkanes	
1.2	**Alkene**	[4L]
	Natural resources and applications, methods of formation: dehydration of alcohol, dehydrohalogenation of alkyl halides, (Saytzeff's rule), partial catalytic hydrogenation of cis and trans alkenes (Lindlar's catalyst and Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), addition of HX (Markownikoff's and anti-Markovnikov's rule), ozonolysis, hydroboration-oxidation	
1.3	**Alkyne**	[4L]
	Natural resources and applications, methods of formation: acetylene from CaC2, conversion of lower alkynes to higher alkynes, by dehalogenation of tetrahalides, dehydrohalogenation of vicinal dihalides. Reactions: formation of metal acetylides, addition of bromine, ozonolysis and oxidation with alk. KMnO4, preparation of benzene	
1.3	**Alkyl Halide**	[3L]
	methods of formation: reaction of alcohols with $SOCl_2$ and PCl_5. Reactions: nucleophilic substitution	

	reactions with hydroxide, alkoxide, cyanide, ammonia, amines, silver acetate, applications	

References:

- Organic Chemistry, Morrison Boyd & Bhattacharjee, edition 7th, 2012- Pearson India
- A Logical Approach to Modern Organic Chemistry, Jagdamba Singh, Pragati Prakashan
- A Textbook of Organic Chemistry by Bahl Arun, Bahl B.S., 22nd edition, Chand publications

Module 2	Periodic table and periodicity	[15L]

Learning Objectives:

This module is intended to:

1. Discuss the evolution of periodic table.
2. classify elements depending upon valence electrons.
3. Describe various physical properties and their trends.
4. Illustrate applications of shielding effect, various scales of electronegativity and their calculation.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Discuss how the periodic table has developed.
2. Describe s, p, d and f block elements and their reactivity pattern
3. Explain the trend in various physical properties and the reason behind the pattern.
4. Solve different numerical based on Slater and Mulliken formula for electronegativity and effective nuclear charge through screening constant

2.1	Periodic table: The need for classification of	[5L]

	elements, history of development of periodic table- Dobereiner's triads, Newland's law of octaves, Mendeleev's periodic law, Modern periodic law, long form of periodic table, IUPAC nomenclature for elements with Z > 100, division of periodic table into s, p, d & f blocks	
2.2	Periodic trends in properties: atomic size, ionization energy, electronegativity, electron affinity, metallic and non-metallic character, valency, atomic volume, density, melting & boiling point, oxidising and reducing properties.	[6L]
2.3	Effective nuclear charge and shielding effect, Slater's rule (problems expected).	[2L]
2.4	Determination of electronegativity using: Allred and Rochow's scale, Mulliken's scale, Pauling's scale.	[2L]

References:

- Concise Inorganic Chemistry, J. D. Lee, 6th Edition.
- Principles of Inorganic Chemistry, Puri, Sharma and Kalia, 6th edition.
- Selected topics in Inorganic Chemistry, Malik, Tuli, Madan, S. Chand Publications, Revised edition.

Question Paper Template

F.Y. B. Sc. (CHEMISTRY) SEMESTER II

Major Core Course- II

COURSE TITLE: Fundamentals of Organic and Inorganic chemistry II

COURSE CODE: 23US2CHMJ2FOI2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	10	10	-	-	-	25
II	5	15	5	-	-	-	25
Total marks per objective	10	25	15	-	-	-	50
% Weightage	20	50	30	-	-	-	100

F. Y. B. Sc. (CHEMISTRY)

SEMESTER II - Practical

COURSE CODE: 23US2CHMJP Credit- 02

Course Learning Outcomes	
After the successful completion of the Course, the learner will be able to: 1. Read a pH strip and identify as an acid, base or neutral compound. 2. Synthesize different organic compounds. 3. Evaluate the analysis of different cations and anions.	
Learning Objectives: The practical is intended to 1. Identify common items as acid, base or neutral. 2. Read a pH strip and identify as acid, base or neutral compound 3. Write characteristics of acids, bases and neutral substances. 4. Separate and Identify different cations and anions 5. Synthesize different organic Compounds	
Learning Outcomes: After the successful completion of the practical, the learner will be able to: 1. Examine pH using indicator and pH meter 2. Identify various cations and anions based on the principles of semi-micro qualitative analysis. 3. Synthesize and purify organic compounds.	
Major Core Course I Section A	**Ionic equilibria**
1. To determine the pH of a given solution through matching its colour	

developed by an indicator. 2. To determine the pH of NH_4Cl, NaCl, Na_2CO_3 and CH_3COONa solutions using pH meter	
Major Core Course I Section B	**Inorganic Qualitative analysis**
Semi-micro analysis of inorganic mixture containing Two cations and Two anions (without interfering anions, minimum 6).	
Major Core Course II	**Organic preparation**
Preparation (recrystallization, determination of melting point and calculation of quantitative yield to be done) of A. Alkaline hydrolysis of methyl salicylate (ester hydrolysis). B. Oxime derivative of acetophenone. C. Nitration of salicylic acid by green method.	
References: • Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. • Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960 • Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.	

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

I) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate to develop a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Mid Semester Examination (MSE) and End Semester Examination (ESE).
- The Mid Semester Examination shall be conducted by the College at the Mid of each semester (20 M) – Duration: 30 Min.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hours

End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 5 Q = 25 M	5 M x 3 Q = 15 M
2	II	5 M x 5 Q = 25 M	5 M x 3 Q = 15 M

Each question will have six sub questions a, b, c, d, e, f and out of which any three should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 50 Marks throughout entire semester.
- 50 Marks Evaluation as per the following rubrics

Major Core Course	CIE	Experimental Report	Viva	Total
MJ I	15 M	5 M	5 M	25 M
MJ I	15 M	5 M	5 M	25 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'U' designates undergraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'CH' is for Chemistry discipline (CH- Chemistry). This forms the programme code 23USCH. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science are used.
8. For Value Added course code, (VA) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science are used.
9. For Indian Knowledge System course code, (IK) alphabets followed by a digit (1/2) followed by 'ICH'- Indian Cultural Heritage is used.
10. For Co-curricular course code, (CC) alphabets followed by a digit (1/2).
11. For Open Elective course code, (OE) alphabets followed by a digit (1/2).
12. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.