SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

B.Sc. Chemistry

Undergraduate Programme

From

Academic year

2021-22

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

Undergraduate and Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Mrs. Madhavi Kate	Chairman	K J Somaiya college of science and commerce
Subject Expert nominated by Vice-Chancellor			
1	Prof. M.M.V. Ramana (Organic Chemistry)	Head, University Department of Chemistry	University of Mumbai
2	Prof. A. K. Shrivastava (Analytical Chemistry)	Ex-Head, University Department of Chemistry	University of Mumbai
3	Prof. B. M. Bhanage (Inorganic chemistry)	Professor, Industrial and Engineering chemistry	ICT, Mumbai
4	Dr. Rajesh Vatsa (Physical Chemistry)	Senior Research Scientist	BARC, Mumbai
Subject experts			
1	Prof. B. M. Bhanage	Professor, Industrial and Engineering chemistry	ICT, Mumbai
2	Dr. Rajesh Vatsa	Senior Research Scientist	BARC, Mumbai
3	Prof. Shivram S. Garje	Professor, University department of Chemistry	University of Mumbai

Representative from Industry/corporate sector/allied area			
1	Dr. Ajit Datar	Advisor	Shimadzu Analytical (I) Pvt. Ltd, Mumbai
2	Dr. Ranjan Mogre	MD	Avtos Life Sciences Pvt. Ltd, Mumbai
Meritorious Alumnus			
1	Ms. Sarah Mullaji,	T.Y.B.Sc. (Chemistry)	K J Somaiya college of science and commerce
2	Shreena Kunumal	M.Sc. Part 1 (Chemistry)	K J Somaiya college of science and commerce
3	Dr. Druman Utekar	Assistant Professor	K J Somaiya College of Engineering, Vidyavihar
Faculty of the specialisation			
1	Dr. Pradnya. J. Prabhu	Principal	K J Somaiya college of science and commerce
2	Dr. Bright O. Philip	Associate Professor	K J Somaiya college of science and commerce
3	Dr. Sugandha Shetye	Associate Professor	K J Somaiya college of science and commerce
4	Dr. Chitra Kamath	Associate Professor	K J Somaiya college of science and commerce
5	Dr. Veena Khilnani	Associate Professor	K J Somaiya college of science and commerce
6	Dr. Nishamol Kanat	Associate Professor	K J Somaiya college of science and commerce
7	Dr. Yogesh Ghalsasi	Associate Professor	K J Somaiya college of science and commerce

8	Dr. Vanita Kulkarni	Associate Professor	K J Somaiya college of science and commerce
9	Dr. Saurabh Shete	Assistant Professor	K J Somaiya college of science and commerce
10	Dr. Trupti Tawde	Assistant Professor	K J Somaiya college of science and commerce
11	Dr. Rohit S. Chauhan	Assistant Professor	K J Somaiya college of science and commerce
12	Dr. Aniket Pawanoji	Assistant Professor	K J Somaiya college of science and commerce
13	Dr. Nanabhau Karanjule	Assistant Professor	K J Somaiya college of science and commerce
14	Dr. Dilip Kumar Yadav	Assistant Professor	K J Somaiya college of science and commerce
15	Dr. Afsar Ali Siddiki	Assistant Professor	K J Somaiya college of science and commerce
16	Dr. Mithun Mondal	Assistant Professor	K J Somaiya college of science and commerce
17	Mr. Jaidip Wable	Assistant Professor	K J Somaiya college of science and commerce
18	Dr. Amol Pawar	Assistant Professor	K J Somaiya college of science and commerce
19	Mrs. Meenakshi Wagh	Assistant Professor	K J Somaiya college of science and commerce
20	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.

Mrs. Madhavi Kate
Chairperson
Board of Studies in Chemistry

Table of Contents

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.

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 the 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 environment 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

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 Learning Outcomes (PLOs)

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

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

PLO 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.

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

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

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

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

5.1 Course Mapping

Semester	PLO	I	II	III	IV	V	VI
	Course						
I	CC I	√		√		√	√
	CC II	√	√	√	√	√	√
	AECC I FC*						
	SEC I STP1						
	SEC II BCE**						
II	CC I	√	√	√			√
	CC II	√	√	√	√	√	√
	AECC I FC*						
	SEC I STP2						
	SEC II ICH1***						
III	CC I	√	√	√	√		
	CC II	√	√	√		√	√
	CC III	√	√	√	√	√	√
	AECC I FC*						
	SEC I STP3						

	SEC II ICH2***						
IV	CC I	√	√	√	√	√	
	CC II		√		√	√	√
	CC III	√	√	√	√	√	√
	AECC I FC*						
	SEC I STP4						
	SEC II ICH3***						
V 6 units	CC I	√	√	√	√	√	√
	CC II		√	√			
	CC III	√	√	√	√	√	
	CC IV	√		√	√	√	√
	DSE I	√	√				√
	DSE II	√	√	√		√	√
	DSE III	√	√	√		√	√
	DSE IV	√	√	√		√	√
	AECC I EVS						
	SEC I	√	√	√			√
	SEC II	√	√	√	√	√	√
VI 6 units	CC I	√	√	√	√	√	√
	CC II		√	√	√		
	CC III	√	√	√	√	√	√

	CC IV	√		√	√	√	√
	DSE I	√	√			√	√
	DSE II	√	√		√	√	√
	DSE III	√	√		√	√	√
	DSE IV	√	√		√	√	√
	AECC I EVS						
	SEC I	√		√		√	
	SEC II	√	√	√	√	√	√
V 3 units	CC I	√	√	√	√	√	√
	CC II	√	√	√	√		
	CC III	For details of these courses refer to the LOCF document of Biochemistry					
	CC IV						
	DSE I						
	DSE II						
	DSE III						
	DSE IV						
	AECC I EVS						
	SEC I	√		√		√	
	SEC II	√	√	√	√	√	√
VI 3 units	CC I	√	√	√	√	√	√
	CC II	√	√	√	√	√	√
	CC III	For details of these courses refer to the LOCF document of Biochemistry					
	CC IV						
	DSE I						

	DSE II						
	DSE III						
	DSE IV						
	AECC I EVS						
	SEC I	√		√		√	
	SEC II	√	√	√	√	√	√

* FC = Foundation Course

** BCE = Basic communication in English

*** ICH = Indian Cultural Heritage (Value Education)

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 and six semesters (two semesters per year). To acquire a degree in B.Sc. chemistry a learner must study

1. Core Courses (CC):

a) A course which is required to be opted by a candidate as a core course.

b) There are eighteen Core courses (CC), two each, in semesters I and II; three each in semesters III and IV and four each in semesters V and VI (for 6 units).

c) Each Core Courses is compulsory.

d) Each CC is comprised of 2 credits for theory ie. 30 hour; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.

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

f) The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular discipline.

2. Ability Enhancement Compulsory Courses (AECC)

a) There are six AECC courses. Student must take one Ability Enhancement Compulsory Courses (AECC) in semester I-VI.

b) The AECC courses offered are:

AECC 1- Foundation Course (2 credits) (Semester I-IV),

AECC 2- Environmental Science (2 credits) (Semester V and VI).

3. Skill Enhancement Course (SEC):

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 Twelve skill enhancement courses offered. Each student is supposed to take two in each semester I-IV (Sports training program, Basic communication in English and Indian Cultural Heritage) of 1 credit each. There are four discipline-related skill enhancement courses (SEC), two offered in each semester V and semester VI each of 2 credit. The student is supposed to choose one SEC in Semester V and VI.

4. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the main discipline subject of study.

b) There are eight discipline specific elective courses (DSE), four in each semesters V and VI. The student is supposed to choose two out of four in each semester V and VI.

c) Each DSE theory course is of 2 credits i.e. 30 hour; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.

d) Research Project is offered as an option for the student to choose in lieu of a regular DSE course

5. Generic Elective Course (GE)

a) Students can opt for one interdisciplinary Generic Elective Course (GE) in each of the semester V and VI.

b) Generic elective courses are offered in cognate disciplines by different departments in the college.

c) Credits for these courses are granted as additional credits.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
Core Course (CC)				
1	I	CC I	21USICHCCIFPII	Fundamentals of Physical and Inorganic Chemistry I
2		CC II	21USICHCC2FOA	Fundamentals of Organic and Analytical chemistry
3		CC P	21USICHCCP	Based on CC I and CC II
4	II	CC I	21US2CHCCIFPI2	Fundamentals of Physical and Inorganic Chemistry II
5		CC II	21US2CHCC2FOR	Fundamentals of Organic Chemistry
6		CC P	21US2CHCCP	Based on CC I and CC II
7	III	CC I	22US3CHCCIPHCI	Physical Chemistry I
8		CC II	22US3CHCC2INCI	Inorganic Chemistry I
9		CC III	22US3CHCC3ORCI	Organic Chemistry I
10		CC P	22US3CHCCP	Based on CC I, CC II and CC III
11	IV	CC I	22US4CHCCIPHC2	Physical Chemistry II
12		CC II	22US4CHCC2INC2	Inorganic Chemistry II
13		CC III	22US4CHCC3ORC2	Organic Chemistry II
14		CC P	22US4CHCCP	Based on CC I, CC II and CC III
15	V 6 Units	CC I	23US5CHCCIPHC3	Physical Chemistry III
16		CC II	23US5CHCC2INC3	Inorganic Chemistry III
17		CCP I	23US5CHCCPI	Based on CC I and CC IV
18		CC III	23US5CHCC3ORC3	Organic Chemistry III

19		CC IV	23US5CHCC4ANC1	Analytical Chemistry I
20		CC P II	23US5CHCCP2	Based on CC II and CC III
21	VI 6 Units	CC I	23US6CHCC1PHC4	Physical Chemistry IV
22		CC II	23US6CHCC2INC4	Inorganic Chemistry IV
23		CC P I	23US6CHCCPI	Based on CC I and CC IV
24		CC III	23US6CHCC3ORC4	Organic Chemistry IV
25		CC IV	23US6CHCC4ANC2	Analytical Chemistry II
26		CC P II	23US6CHCCP2	Based on CC II and CC III
27	V 3 Units	CC I	23US5BCHCC1PAC1	Physical-Analytical Chemistry I
28		CC II	23US5BCHCC2IOC1	Inorganic-Organic Chemistry I
29		CC P	23US5BCHCCP	Based on CCI and CC II
30	VI 3 Units	CC I	23US6BCHCC1PAC2	Physical-Analytical Chemistry II
31		CC II	23US6BCHCC2IOC2	Inorganic-Organic Chemistry II
32		CC P	23US6BCHCCP	Based on CCI and CC II
Discipline Specific Electives (DSE)				
1	V 6 Units	DSE I	23US5CHDS1FDC	Fundaments of drug chemistry
2		DSE II	23US5CHDS2ERC	Essentials of radiation chemistry
3		DSE III	23US5CHDS3RMC	Research methodology in chemistry
4		DSE IV	23US5CHDS4ENC	Environmental chemistry

5		DSE P	23US5CHDSP	Practical Based on DSE Courses
6	VI 6 Units	DSE I	23US6CHDS1IDC	Introduction to dyestuff chemistry
7		DSE II	23US6CHDS2PSC	Pesticide chemistry
8		DSE III	23US6CHDS3PLC	Polymer
9		DSE IV	23US6CHDS4INC	Industrial Chemistry
10		DSE P	23US6CHDSP	Practical Based on DSE Courses
Skill Enhancement Courses (SEC)				
1	I	SEC I	21US1SE1STP1	Sports Training Programme Level I
2		SEC II	21US1SE2BCE	Basic Communication in English
3	II	SEC I	21US2SE1STP2	Sports Training Programme Level II
4		SEC II	21US2SE2ICH1	Indian cultural Heritage Level I (value education)
5	III	SEC I	22US3SE1STP3	Sports Training Programme Level III
6		SEC II	22US3SE2ICH2	Indian cultural Heritage Level II (value education)
7	IV	SEC I	22US4SE1STP4	Sports Training Programme Level IV
8		SEC II	22US4SE2ICH3	Indian cultural Heritage Level III (value education)
9	V	SEC I	23US5CHSE1BSC	Business skills for chemist

10	[6 + 3] Units	SEC II	23US5CHSE2GLC	Gas and liquid chromatography
11	VI [6 + 3] Units	SEC I	23US6CHSE1COC	Chemistry of Cosmetics
12		SEC II	23US6CHSE2DAC	Dairy chemistry
Ability Enhancement Compulsory Course (AECC)				
1	I	AECC I	21US1AE1FOC	Foundation Course
2	II	AECC I	21US2AE1FOC	Foundation Course
3	III	AECC I	22US3AE1FOC	Foundation Course
4	IV	AECC I	22US4AE1FOC	Foundation Course
5	V [6 + 3] Units	AECC I	23US5AE1EVS	Environmental Science
6	VI [6 + 3] Units	AECC I	23US6AE1EVS	Environmental Science

6.2 Credit distribution for B.Sc. Chemistry

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	CC I	Fundamentals of Physical and Inorganic Chemistry I	2	1	3
	CC II	Fundamentals of Organic and Analytical chemistry	2	1	3
	AECC I	Foundation Course	2		2

	SEC I	Sports Training Programme Level I	1		1
	SEC II	Basic Communication in English	1		1
II	CC I	Fundamentals of Physical and Inorganic Chemistry II	2	1	3
	CC II	Fundamentals of Organic Chemistry	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Programme Level II	1		1
	SEC II	Indian cultural Heritage Level I (value education)	1		1
III	CC I	Physical Chemistry I	2	1	3
	CC II	Inorganic Chemistry I	2	1	3
	CC III	Organic Chemistry I	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Programme Level III	1		1
	SEC II	Indian cultural Heritage Level II (value education)	1		1
IV	CC I	Physical Chemistry II	2	1	3
	CC II	Inorganic Chemistry II	2	1	3
	CC III	Organic Chemistry II	2	1	3
	AECC I	Foundation Course	2		2
	SEC I	Sports Training Programme Level IV	1		1

	SEC II	Indian cultural Heritage Level III (value education)	1		1
V 6 Units	CC I	Physical Chemistry III	2	1	3
	CC II	Inorganic Chemistry III	2	1	3
	CC III	Organic Chemistry III	2	1	3
	CC IV	Analytical Chemistry I	2	1	3
	DSE I/II	Fundaments of drug chemistry or Essentials of radiation chemistry	2	1	3
	DSE III/IV	Research methodology in chemistry or Environmental chemistry	2	1	3
	AECC I	Environmental science	2		2
	SEC I/II	Business skills for chemist or Gas and liquid chromatography	2		2
VI 6 Units	CC I	Physical Chemistry IV	2	1	3
	CC II	Inorganic Chemistry IV	2	1	3
	CC III	Organic Chemistry IV	2	1	3
	CC IV	Analytical Chemistry II	2	1	3
	DSE I/II	Introduction to dyestuff chemistry or Pesticides chemistry	2	1	3
	DSE III/IV	Polymer or Industrial Chemistry	2	1	3
	AECC I	Environmental science	2		2

	SEC I/II	Chemistry of cosmetics or Dairy chemistry	2		2
V 3 Units	CC I	Physical-Analytical Chemistry	2	1	3
	CC II	Inorganic-Organic Chemistry	2	1	3
	CC III	Biochemistry Courses	2	1	3
	CC IV		2	1	3
	DSE I/II		2	1	3
	DSE III/IV		2	1	3
	AECC I	Environmental science	2		2
	SEC I/II	Business skills for chemist or Gas and liquid chromatography	2		2
VI 3 Units	CC I	Physical-Analytical Chemistry	2	1	3
	CC II	Inorganic-Organic Chemistry	2	1	3
	CC III	Biochemistry Courses	2	1	3
	CC IV		2	1	3
	DSE I/II		2	1	3
	DSE III/IV		2	1	3
	AECC I	Environmental science	2		2
	SEC I/II	Chemistry of cosmetics or Dairy chemistry	2		2

6.3 Semester Schedule

Semester	Core Course number	Core Course (CC) title	Discipline Specific Electives (DSE)	Generic Elective Course (GE)	Skill Enhancement Course (SEC)	Ability Enhancement Compulsory Course (AECC)
I	CC I	Fundamentals of Physical and Inorganic Chemistry I	-	-	1] Sports Training Programme Level I 2] Basic Communication in English	Foundation Course
	CC II	Fundamentals of Organic and Analytical chemistry	-	-		
II	CC I	Fundamentals of Physical and Inorganic Chemistry II	-	-	1] Sports Training Programme Level II 2] Indian cultural Heritage Level I (Value Education)	Foundation Course
	CC II	Fundamentals of Organic Chemistry	-	-		
III	CC I	Physical Chemistry I	-	-	1] Sports Training	Foundation Course

	CC II	Inorganic Chemistry I	-	-	Program Level III 2] Indian cultural Heritage Level II (Value Education)	
	CC III	Organic Chemistry I	-	-		
IV	CC I	Physical Chemistry II	-	-	1] Sports Training Program Level IV 2] Indian cultural Heritage Level III (Value Education)	Foundation Course
	CC II	Inorganic Chemistry II	-	-		
	CC III	Organic Chemistry II	-	-		
V 6 Units	CC I	Physical Chemistry III	DSE I/II and DSE III/IV	GE	SEC I/II	Environmental Science
	CC II	Inorganic Chemistry III				
	CC III	Organic Chemistry III				
	CC IV	Analytical Chemistry I				

VI 6 Units	CC I	Physical Chemistry IV	DSE I/II and DSE III/IV	GE	SEC I/ II	Environmental Science
	CC II	Inorganic Chemistry IV				
	CC III	Organic Chemistry IV				
	CC IV	Analytical Chemistry II				
V 3 Units	CC I	Physical-Analytical Chemistry I	Biochemistry course	GE	SEC I/ II	Environmental Science
	CC II	Inorganic-Organic Chemistry I				
	CC III	Biochemistry course				
	CC IV					
VI 3 Units	CC I	Physical-Analytical Chemistry II	Biochemistry course	GE	SEC I/ II	Environmental Science
	CC II	Inorganic-Organic Chemistry II				
	CC III	Biochemistry course				
	CC IV					

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 2021–2022

Syllabus – F. Y. B.Sc. Chemistry

Course No.	Course Title	Course Code	Credits	Hr.	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
SEMESTER I										
Core courses THEORY										
I	Fundamentals of Physical and Inorganic Chemistry I	21USICHC CIFPII	2	30	36	3	12	40	60	100
II	Fundamentals of Organic and Analytical chemistry	21USICHC C2FOA	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
		21USICHC CP	2	75	90			40	60	100
SEMESTER II										
Core courses THEORY										
I	Fundamentals of Physical and Inorganic Chemistry II	21US2CHC CIFPI2	2	30	36	3	12	40	60	100
II	Fundamentals of Organic Chemistry	21US2CHC C2FOR	2	30	36	3	12	40	60	100
Core courses PRACTICAL										
		21US2CHC CP	2	75	90			40	60	100

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

Core Course- I

COURSE TITLE: Fundamentals of Physical and Inorganic Chemistry I

COURSE CODE: 21USICHCCIFPI1 [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Illustrate the behaviour of real gases and measure the properties of liquids to solve real life problems like liquefaction of gases, treatment of oil spills, use of motor oil and lubricants. 2. Compare the trends in properties of the elements in the periodic table. 3. Explain the various theories of chemical bonding and predict the structure of the molecules.

Module 1	States of Matter	[12L]

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 of state, its derivation and application in explaining real gas behaviour.	[4L]
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. Liquid State: Introduction to liquid state, characteristics of liquid state, physical properties of the liquids	[4L]
1.3	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 problems on surface tension and viscosity measurements are expected	[4L]

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	Periodic table and Periodic properties	[12L]

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	• The need for classification of elements • Attempts of classification of elements: - Dobereiner's triads, Law of octaves, Mendeleev's periodic table. • Modern periodic Law, cause of periodicity, Long form of periodic table.	[4L]

	• IUPAC nomenclature for elements with Z > 100 • Division of periodic table into s, p, d & f blocks.	
2.2	periodic trends in properties. • Valency • Atomic volume • Atomic size • Ionization energy • Electron affinity • Melting & boiling point • Electronegativity • Electro positivity & metallic character	[5L]
2.3	• Effective nuclear charge and shielding effect • Slater's rule (problems expected)	[2L]
2.4	Determination of Electronegativity using: • Mulliken's scale • Pauling's scale.	[1L]

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.

Module 3	Chemical Bonding	[12L]

Learning Objectives:

The 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.		
3.1	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, Madelung constant and Kapustinskii equation.	[3L]
3.2	Covalent bond, formation of covalent bond, energy changes in the formation of covalent bond, characteristics of covalent compound, electron dot structure, Valence bond theory, 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: 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^-	[6L]
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.
- Textbook of inorganic chemistry, Anilkumar De

Question paper Template

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

Core Course- I

COURSE TITLE: Fundamentals of Physical and Inorganic Chemistry I

COURSE CODE: 21USICHCCIFPI1 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	11	08	05	03	03	-	30
II	13	09	03	03	02	-	30
III	10	09	06	03	02	-	30
Total marks per objective	34	26	14	09	07	-	90
% Weightage	38	29	16	10	07	-	100

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

Core Course- II

COURSE TITLE: Fundamentals of Organic and Analytical chemistry

COURSE CODE: 21USICHCC2FOA [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Apply IUPAC nomenclature to aliphatic and aromatic compounds. 2. Relate the fundamentals of organic chemistry with stability, reactivity and structure. 3. Illustrate the methods of preparation, properties and reactions of aliphatic hydrocarbons. 4. Discuss the basic concepts of qualitative and quantitative chemical analysis.		
Module 1	Fundamentals of organic chemistry and IUPAC nomenclature of organic compounds	[12L]
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	Fundamentals of Organic Chemistry: • Cleavage of Bonds: Homolysis and Heterolysis. • Structure, shape and reactivity of organic molecules: Nucleophiles and Electrophiles. • Reactive Intermediates: Carbocations, Carbanions and free radicals' generations and its reactivity • Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation.	[6L]
1.2	IUPAC nomenclature of Organic compounds: • Types of organic compounds. Nomenclature of aliphatic compounds. • Priority rules • Nomenclature of bifunctional compounds. • Nomenclature of benzene derivatives, mono, di and polysubstituted derivatives.	[6L]
References: • Organic Chemistry, Morrison Boyd & Bhattacharjee, edition 7th, 2012- Pearson India • A Logical Approach to Modern Organic Chemistry, Jagdamba Singh, Pragati Prakashan		

<table>
<tr><td colspan="3">

- A Textbook of Organic Chemistry by Bahl Arun, Bahl B.S., 22nd edition, Chand publications.

</td></tr>
<tr><th>Module 2</th><th>Aliphatic Hydrocarbons</th><th>[12L]</th></tr>
<tr><td colspan="3">

Learning Objectives:

This module is intended to:

1. Define and identify alkane, alkene and alkyne
2. List some properties and applications of aliphatic hydrocarbons
3. Discuss the synthesis and characteristic reactions of aliphatic hydrocarbons

</td></tr>
<tr><td colspan="3">

Learning Outcomes:

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

1. Discuss basic practical skills for synthesis of aliphatic hydrocarbons.
2. Predict the reactivity of aliphatic hydrocarbons from their structure
3. Write mechanistic aspects of these reactions and illustrate their application in multi-step synthesis

</td></tr>
<tr><td>2.1</td><td>Alkanes:
Natural resources and applications
Preparation: by Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent.by decarboxylation
Reactions: Free radical Substitution: Halogenation with mechanism</td><td>[4L]</td></tr>
<tr><td>2.2</td><td>Alkenes:
Natural resources and applications,
Preparation: Dehydration of alcohol, dehydrohalogenation of alkyl halides, (Saytzeff's rule), Partial catalytic hydrogenation of cis and</td><td>[4L]</td></tr>
</table>

	trans alkenes (Lindlar's catalyst and Birch reduction). • Reactions: cis--addition (alk. $KMnO_4$) and trans--addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's rule), Ozonolysis, Hydroboration-oxidation.	
2.3	Alkynes: • Natural resources and applications • Preparation: Acetylene from CaC_2, 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. $KMnO_4$, Formation of benzene	[4L]

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 3	Principles of qualitative and quantitative analysis	[12L]

Learning Objectives:

The 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 volumetric analysis, its classification, basic theory and techniques, indicator theory, calibration of glassware 6. Discuss gravimetric analysis, its type, basic principle of indirect method & its technique 7. 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		
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. Explain the classical method of chemical analysis such as volumetric and gravimetric analysis, its basic principle and techniques with suitable examples. 4. Differentiate classical method and instrumental methods 5. 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		
3.1	Chemical Analysis: Introduction to analytical methods, steps in chemical analysis, classification based on (1)	[IL]

	sample size (2) type of information (3) property measurements, application of analytical methods	
3.2	Qualitative analysis: Theory of elemental analysis of organic compound, concept of common ion effect and solubility products in semi-micro inorganic separation, complexation and oxidation number	[2L]
3.3	Quantitative analysis: Introduction to the types (Classical and Instrumentations)	[1L]
3.3.1	Volumetric Analysis: Standard solutions and its type, classification of volumetric Analysis with suitable example, basic theory, technique and apparatus, calibration of glassware, applications, Concept of indicator and it's theory	[3L]
3.3.2	Gravimetric Analysis: Introduction, types, emphasis on indirect methods- principle, technique, applications	[2L]
3.4	Chemical calculation: mole concept, mole fraction, equivalent weight of acid, base, salt, reducing agent and oxidising agent, molarity, molality, normality, ppm and ppb	[3L]

References:

- Vogel's qualitative inorganic analysis, 7th edition.
- Quantitative Analysis, 4th Edition (Day, R. A.; Underwood, A. L.)
- Vogel's quantitative inorganic analysis, 6th edition.
- Fundamental of Analytical chemistry, D. A. Skoog.

Question Paper Template

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

Core Course- II

COURSE TITLE: Fundamentals of Organic and Analytical chemistry

COURSE CODE: 21USICHCC2FOA [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	08	09	05	05	03	-	30
II	09	09	06	03	03	-	30
III	08	07	05	05	05	-	30
Total marks per objective	25	25	16	13	11	-	90
% Weightage	28	28	18	14	12	-	100

F. Y. B. Sc. (CHEMISTRY)

SEMESTER I - Practical

COURSE CODE: 21USICHCCP Credit- 02

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).

Core Course I Section A	Calibration of apparatus and standardization of solutions

1. Calibration of pipettes and standard flasks
2. Standardisation of NaOH using succinic acid and Standardisation of $KMnO_4$ using oxalic acid.

Core Course I Section B	Volumetric Analysis -Estimation

1. Estimation of Sodium carbonate & sodium bicarbonate present in a mixture.
2. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicators.

Core Course II	Organic Spotting

Identification of organic compounds

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

Core Course- I

COURSE TITLE: Fundamentals of Physical and Inorganic Chemistry II

COURSE CODE: 21US2CHCCIFPI2 [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Explain the basic concepts of thermodynamics. 2. Apply concepts of Chemical equilibrium. 3. Solve numerical problems based on Ionic equilibria.

Module 1	Thermodynamics & Chemical Energetics	[12L]

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

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

1.1	Introduction and significance of thermodynamics. Some basic terms of thermodynamics, First Law of Thermodynamics. 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	[6L]
1.2	Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's equation. (Numerical expected)	[3L]
1.3	Second Law of thermodynamics: Concept of entropy and Carnot Cycle Statement of Third law of thermodynamics	[3L]

References:

- Puri, Sharma and Pathania, Principles of Physical Chemistry, 44th Edn., Vishal Publishing Co.
- Arun Bahl, J.D. Tuli, Essentials of Physical Chemistry, S. Chand Publishing Co
- Samuel Glasstone, Text book of Physical Chemistry

Module 2	Chemical Equilibrium	[12L]
Learning Objectives: This module is intended to: 1. Describe chemical equilibrium and equilibrium constant. 2. Differentiate between homogeneous and heterogeneous equilibria 3. Explain the application of thermodynamic concepts to equilibrium systems. 4. Discuss the factors that alter the state of chemical equilibrium		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Explain chemical equilibrium and characteristics of equilibrium constant. 2. Apply the thermodynamic concept of free energy change to equilibrium reactions. 3. Predict the outcome of reactions at equilibrium when factors such as concentration, pressure or temperature are changed.		
2.1	Chemical equilibrium-concept, definition. Law of mass action. Equilibrium constant (K), Relation between Kp, Kc and Kx. Characteristics of equilibrium constant. Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium, van't Hoff reaction isotherm, Distinction between ΔG and ΔGO. (Numerical expected)	[5L]
2.2	Homogeneous and heterogeneous equilibria. Temperature dependence of the equilibrium Constant (van't Hoff's equation), Integrated form of the van't Hoff's equation. Pressure dependence of equilibrium constant. (Numerical expected)	[5L]

2.3	Factors that alter the state of equilibrium: Le Chatelier's Principle, examples.	[2L]

References:

- Puri, Sharma and Pathania, Principles of Physical Chemistry, 44th Edn., Vishal Publishing Co.
- Arun Bahl, J.D. Tuli, Essentials of Physical Chemistry, S. Chand Publishing Co
- Samuel Glasstone, Text book of Physical Chemistry

Module 3	Ionic Equilibrium	[12L]

Learning Objectives:

The module is intended to

1. Discuss the concept of electrolytes, its type
2. Explain the dissociation/ionisation and degree of ionisation
3. Acquire knowledge for acid-base theories, relative strength of acid and bases, Ostwald's dilution law
4. Describe the core concepts of common ion effect and solubility products.
5. Illustrate the salt, its types and salt hydrolysis, buffer, its action, Henderson-Hasselbach equation and significance
6. 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. Explain the fundamentals of conductors such as electrolyte and metal conductor, types of electrolytes.

2. Describe the concept of acid & base, degree of dissociation, Ostwald's dilution law, ionic product of water, pH scale. 3. Discuss the concept of common ion effect, Solubility & solubility product. 4. Illustrate the concept of buffer, its mechanism, Henderson equation, salt and its hydrolysis. 5. Predict the strength of electrolytes and differentiate acid-bases 6. 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		
3.1	Conductors: metallic or electronic conductors and Electrolytic conductors or electrolytes, types of electrolyte (weak, moderate and strong), dissociation and ionisation, degree of dissociation, factors affecting degree of dissociation	[1L]
3.2	Concept of acid & base: Arrhenius theory, Bronsted-lowery theory, Lewis theory, dissociation constants of acid and base, relative strength of acid and bases, Oswald's dilution law	[3L]
3.3	Ionic product of water, pH scale	[1L]
3.4	Common ion effect, Solubility and solubility products and its applications	[2L]
3.5	Salt, its types and salt hydrolysis	[2L]
3.6	Buffer: Types, capacity, mechanism of action, Henderson-Hasselbach equation and significance (Numericals expected)	[3L]

References:

- Puri, Sharma and Pathania, Principles of Physical Chemistry, 44th Edn., Vishal Publishing Co.
- Arun Bahl, J.D. Tuli, Essentials of Physical Chemistry, S. Chand Publishing Co
- Samuel Glasstone, Text book of Physical Chemistry

Question Paper Template

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

Core Course- I

COURSE TITLE: Fundamentals of Physical and Inorganic Chemistry II

COURSE CODE: 21US2CHCC1FPI2 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	10	10	05	03	02	-	30
II	11	09	05	03	02	-	30
III	08	07	05	05	05	-	30
Total marks per objective	29	26	15	11	09	-	90
% Weightage	33	29	17	12	09	-	100

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

Core Course- II

COURSE TITLE: Fundamentals of Organic Chemistry

COURSE CODE: 21US2CHCC2FOR [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Illustrate the various chemical reactions of alkyl and aryl halide. 2. Justify the mechanism of nucleophilic substitution reaction (SN^1, SN^2 and SN^i) 3. Discuss the synthesis, characteristic reactions and relative reactivity of carbonyl compounds. 4. Elaborate methods of preparation, reactions of alcohol, phenol and ethers.

Module 1	Alkyl and Aryl Halide	[12L]

Learning Objectives:

The module is intended to

1. Define alkyl and aryl halide
2. Discuss the applications of alkyl and aryl halide
3. Describe different methods of preparations of alkyl halide such as from alcohol by using HX, PCl_3, PCl_5, $SOCl_2$, Swarts, Finkelstein reaction and aryl halides by Sandmeyer & Gattermann reactions
4. Elaborate the types of Nucleophilic Substitution (SN^1, SN^2 and SN^i) reactions with mechanism and stereochemistry
5. Write the characteristic reactions of alkyl and aryl halide (Chemical properties)

Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Evaluate the importance of alkyl and aryl halide in organic chemistry 2. Depict the preparations methods and reactions of alkyl and aryl halide 3. Discuss the basic practical skills for the synthesis of alkyl halides.		
1.1	Alkyl Halides • Introduction and applications, • Preparation: from alcohol (using HX, PX_3, PCl_5, $SOCl_2$), By halogen exchange (Swarts and Finkelstein) • Reactions: Formation of alcohol, nitrite & nitro, amine, nitrile & isonitrile, ether • Types of Nucleophilic Substitution (SN^1, SN^2 and SN^i) reactions with mechanism and stereochemistry • Elimination vs substitution	[7L]
1.2	Aryl Halides • Introduction and applications, • Preparation: (Chloro, bromo and iodo benzene case): from phenol, Sandmeyer & Gattermann reactions. • Reactions (Chlorobenzene): Aromatic nucleophilic substitution with mechanism (replacement by OH group) and effect of nitro substituent. • Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).	[5L]

	• Reactivity and Relative strength of C Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.	

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	Chemistry of carbonyl compounds	[12L]

Learning Objectives:

This module is intended to:

1. Define and identify various carbonyl compounds
2. List some properties and applications of Carbonyl compounds
3. Discuss the synthesis and characteristic reactions of aldehyde and ketone
4. Outline the synthesis of a given carboxylic acid from the appropriate amide, ester, anhydride, acyl halide
5. Outline the synthesis of a given amide, ester, anhydride, acyl halide from the appropriate carboxylic acid

Learning Outcomes:

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

1. Evaluate the importance of carbonyl function in organic chemistry
2. Illustrate the preparations methods and reactions of aldehyde and ketone
3. Design reactions of carboxylic acids and their derivatives

2.1	Aldehydes and ketones (aliphatic)	[7L]

	• Preparation: from calcium salt of carboxylic acid, from alkyne, from geminal dihalides, from acid chlorides and from nitriles • Reactions: Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives, Iodoform test. Aldol Condensation, Cannizzaro's reaction, Clemensen reduction, Wolff Kishner reduction, Meerwein Pondorff Verley reduction. • Relative reactivity of aldehyde and ketone	
2.2	Carboxylic acid and its derivatives (aliphatic): • Introduction and applications, • Carboxylic acids Preparation: From Acid chlorides, Anhydrides, Esters and Amides • Reactions: Hell Volhard Zelinsky Reaction, Preparation of Acid chlorides, Anhydrides, Esters and Amides • Acidity of carboxylic acid • Comparative study of nucleophilicity of acyl derivatives.	[5L]

References:

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- 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 3	Alcohol, Phenol and Ether	[12L]
Learning Objectives: The module is intended to 1. Define and identify various alcohol, phenol and ether compounds 2. List some properties and applications of alcohol, phenol and ether compounds 3. Discuss the synthesis and characteristic reactions of alcohol, phenol and ether		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Evaluate the importance of alcohol, phenol and ether functional group in organic chemistry 2. Illustrate the preparations methods and reactions of alcohol, phenol and ether 3. Design reactions of alcohol, phenol and ether		
3.1	Alcohols: • Introduction and applications, • Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Reduction of aldehydes, ketones, carboxylic acid and Esters. • Reactions: With sodium, esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate), Oppeneauer oxidation.	[5L]
3.2	Phenols: • Introduction and applications, • Preparation: From Cumene, from aniline.	[4L]

	• Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer Tiemann Reaction, Kolbe's reaction, Houben Hoesch Condensation, Schotten Baumann Reaction	
3.3	Ethers (aliphatic and aromatic): • Introduction and applications, • Preparation - from alcohol, from diazomethane, • Reaction: Cleavage of ethers with HI.	[3L]

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

Question Paper Template

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

Core Course- II

COURSE TITLE: Fundamentals of Organic Chemistry

COURSE CODE: 21US2CHCC2FOR [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	09	09	06	03	03	-	30
II	09	09	06	03	03	-	30
III	09	09	06	03	03	-	30
Total marks per objective	27	27	18	09	09	-	90
% Weightage	30	30	20	10	10	-	100

F. Y. B. Sc. (CHEMISTRY)

SEMESTER II - Practical

COURSE CODE: 21US2CHCCP Credit- 02

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.

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

Core Course I Section B	Inorganic Qualitative analysis

Semi-micro analysis of inorganic mixture containing Two cations and Two anions

Core Course II	Organic preparation

1. Preparation of
   A. Ester Hydrolysis
   B. 2,4-DNP of acetone
   C. Nitro derivative of salicylic acid
2. Recrystallization, determination of melting point and calculation of quantitative yield to be done

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 fifty minutes 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: Continuous Internal Assessment (CIA) & Semester End Examination.
- The Semester End Examination shall be conducted by the College at the end of each semester.
- Semester End Examination (external) (60 M)- Duration:
  2 hours Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M
2	II	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M
3	III	5 M x 6 Q = 30 M	4 M x 5 Q = 20 M

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

- For Internal Evaluation (40 M)

i. Mid Sem Examination 25 M

ii. Workshop/Project/Industrial Visit/ Excursion/ Seminar/ Assignment/ Research paper review 15 M

Or

i. Project (40 M)

Evaluation pattern: Practical

- Semester-end evaluation: 30 Marks practical examination for each Course at the end of semester.
- Internal evaluation 20 marks as per the following rubrics

Experimental Work	Experimental Report	Quiz	Total
10 M	5 M	5 M	20M

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 (21- year of implementation is 2021-22)
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 21USCH. For the further course codes programme code is amended as follows
5. To designate the semester, add the digit (1-6) after S in the programme code. (Eg: 21US1CH- for semester I)
   For the further course codes, addition to the programme code should be done as per the following instructions.
6. To represent core courses (CC) 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 Skill enhancement courses code (SE) followed by digits (1/2/3) followed by letters 'STP'-Sports training programme, 'BCE'-Basic communication in English, 'ICH'-Indian cultural heritage, followed by digits (1/2/3) representing the levels are used. In case of subject related SEC, (SE) followed by digits (1/2/3) followed by a three lettered code representing the title of the course are used.
9. For Discipline specific elective course (DS) of Semester V and VI, (DS) followed by digits (1/2/3/4) followed by a three lettered code representing the title of the course are used.
10. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.