CENTRAL UNIVERSITY OF HARYANA

(*Established under the Central Universities Act, 2009*)

(NAAC Accredited 'A' Grade)

Curriculum and Syllabi
Of
Integrated B.Sc.-M.Sc. (Chemistry)

(For the students enrolled in 2021 only)

DEPARTMENT OF CHEMISTRY
SCHOOL OF BASIC SCIENCES

	BOS	School Board	Academic Council
Approved by :			
Approval Status :	√	√	√
Approval Date :	06-09-2022	12-09-2022	07-10-2022

Table of Contents

VISION AND MISSION

i) Vision and Mission of the University

Vision

To develop enlightened citizenship of a knowledge society for peace and prosperity of individuals, nation and the world, through promotion of innovation, creative endeavours, and scholarly inquiry.

Mission

To serve as a beacon of change, through multi-disciplinary learning, for creation of knowledge community, by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India. The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research and innovation in pure and applied areas of learning.

ii) Vision and Mission of the Department

Vision

To establish a world-class teaching and research reputation of the department that contributes to society through its innovative, creative and scholarly approach.

Mission

To educate the students by adopting highest academic and professional standards to meet the global competency in the field of chemical sciences. To establish and maintain a high quality of support, research facilities, multidisciplinary and skill-based learning opportunities to our staff, students and researchers to orient them to world class creative and innovative minds.

1. BACKGROUND

i) NEP-2020 and LOCF an integrated Approach

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in the 32nd meeting of the Academic Council of the University held on April 23, 2021. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasising upon—integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills;

community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical , vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to

deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

ii) About Chemistry

Chemistry is the science of matter and its transformations. It addresses fundamental questions about the observable matter, ranging from its components, structure, properties and interconversions. As a system of knowledge, Chemistry not only explains the existence and behavior of matter around and within us, but also empowers us to manipulate the matter into new and improved forms for our use. From the ancient practices of rasayan vidya and alchemy, modern chemistry has grown over centuries into a formidable science that touches all aspects of human life. Humanity's progress in the last three centuries is pivoted on the contributions of chemistry, chemical industry and associated endeavors. The range of influence of chemistry in our life spans from essentials such as food (agrochemicals, preservatives), shelter (cement, metals, alloys, polymers) and health (drugs, cosmetics, soap, toothpaste), to advancements such as textiles (polymers, leather), beverages (flavoring and fermentation), crime fighting (forensics), weaponry (explosives), space travel (fuel) and cosmology (element detection). The list can go on endlessly. The most visible contribution of chemistry to civilization is achieved by the advancements in modern medicine that was

fuelled by organic chemistry. This led to significant improvements in the living standards, extension of human average life span and fighting of dangerous diseases such as cancer and microbial infections.

Chemistry is placed centrally between the other two major branches of science, namely physics and biology. Therefore, it is often called the *central science*. It influences the developments in these two broad realms of science as much as it is influenced by the discoveries in them. The fundamental importance of chemistry and chemical industry in sustaining human civilization demands for a steady supply of trained and skilled manpower. Thus, it is unsurprising that it is an essential and integral department in higher education institutions.

Education in chemistry not only imparts the technical know-how about structure, reactions and properties of matter, but also empowers the learner to raise fundamental questions about various natural phenomena, address local issues and come up with sustainable solutions, identify areas of life where intervention of chemistry can bring about progress and imbibe and spread the spirit of free enquiry and scientific temper.

iii) About the Programme (Nature, Extent and Aims)

The integrated B.Sc.-M.Sc. Programme in Chemistry will impart advanced knowledge of basic and applied chemical sciences to the graduates. It will prepare the students for taking up challenging assignments in academia and industry and also empower them with skill and knowledge for generating employment for their own and others. The Programme introduces the students to advanced developments in chemical sciences as well as in the field of other allied sciences, by providing them multidisciplinary and interdisciplinary courses. The design of choice-based curriculum can enrich students with analytical and problem-solving capabilities. It is designed to bring out the best of the abilities of each student, allow them to

sharpen the scientific temper and be abreast with the contemporary developments in the area.

The programme includes a balanced combination of *Core*, *Elective* and *Ability Enhancement* Courses. The courses are designed in such a way to cover the entire spectrum of chemical sciences from fundamentals (that will bring admitted students from various backgrounds to a common level) to most recent advancements in the field (that will make them ready to take up challenging assignments in the real world).

The integrated B.Sc.-M.Sc. Programme in Chemistry is of a five-year duration which is divided into ten semesters. The teaching and learning in the Programme will involve theory (lectures), practicals, tutorial and seminar-based classes. During the whole programme about 40 % syllabus of each course may be delivered via online mode and with a blended teaching-learning approach.

The curriculum will be taught through formal lectures with the aid of pre-made presentations, audio and video tools whenever necessary. Other teaching aids can also be used as and when required. The additional requirements like industrial visits, summer training and project work are also incorporated into the curriculum.

The Aims of the programme include

- To inculcate basic to advanced knowledge of chemical sciences among students.
- To provide higher education, disciplinary and inter/multi-disciplinary research-oriented knowledge to the students to make them lifelong learners.
- To provide a learned, skilled and creative pool of graduates who are ready to take up challenging assignments in different kinds of chemical industries, research institutions and academia.

- To mould responsible, proactive citizens who are equipped with scientific thinking and skills to address problems of their locality
- Adequate blend of theory, computation and hands-on experiments.
- Modernized lab courses – close to recent/current research.

iv) Qualification Descriptors (possible career pathways)

On successful completion of the Integrated B.Sc.-M.Sc. Chemistry Programme, students of the department are expected to be ready to take up opportunities all around the world in areas that demand skills in chemical and allied sciences. As the chemical industry is enormously vast and diverse, numerous opportunities and challenges await the graduates. The graduates are expected to satisfactorily address the professional expectations, maintain a work-life balance and lead productive and meaningful lives. Some of the possible career paths for the undergraduate and postgraduate students may be:

1. Teaching and Research in academia

2. Research scientists in pharmaceutical and other chemical and material industries

3. Research scientists in other allied sciences

4. Entrepreneurship in chemical science-based ventures

5. Administrative Assignments in various government and private agencies

6. Chemist/Scientist/Technician assignments in any of the following industries: pharmaceutical, polymers, petrochemicals, materials sciences, nanotechnology, fuels, non-conventional energy, renewable resources, agrochemicals, fermentation and processing, paints and pigments, metallurgy, packaging, cosmetics, cements, natural products, forensics, explosives, and any other various allied branches of chemistry.

2. STRUCTURE OF INTEGRATED B.Sc.-M.Sc. PROGRAMME

The Integrated B.Sc.-M.Sc. Chemistry Programme is of a *five-year* duration which is divided into ten semesters. The programme under Choice-Based Credit System (CBCS) includes a balanced combination of *Core*, *Elective* and *Ability Enhancement Courses* (Compulsory and Skill based). Distribution of the courses for undergraduate programme (for first three years) is given in **Table-1**.

The programme offers exit options to the students as per the relevant ordinances of CUH and guidelines of UGC and Ministry of Education.

After successful completion of five years (ten semesters) of the programme the candidate will be awarded with the Integrated Degree i.e. **Integrated B.Sc.-M.Sc. (Chemistry)**.

Table 1 (Credit % age of courses for first three years of the Programme)

Sr. No.	Types of Courses	Nature	Total Credit	Credit % age of Courses	% age of Courses
1	**Core Courses (CC)**	Compulsory Courses (CC)	84	56.75	53.85
2	**Elective Courses (EC)**	Discipline Specific Elective Courses (DSE)	24	16.21	15.38
		Generic Elective Courses (GE)	24	16.21	15.38
3	**Ability Enhancement Courses (AEC)**	Ability Enhancement Compulsory Courses (AECC)	8	5.40	7.69
		Ability Enhancement Elective (Skill Based) (SEC)	8	5.40	7.69
			148	**100**	**100**

Course Structure (Chemistry Major)

Details of courses for first three years

Courses	**Credits*** Theory+ Practical	**Credits*** Theory + Tutorial
I. Core Courses **(14 Papers)**	14×4 = 56	14×5 = 70
Core Course Practical / Tutorial* **(14 Papers)**	14×2 = 28	14×1= 14
II. Elective Courses **(8 Papers)**		
A.1. Discipline Specific Elective **(4 Papers)**	4×4 = 16	4×5 = 20
A.2. Discipline Specific Elective Practical/Tutorial* **(4 Papers)**	4×2 = 08	4×1 = 04
B.1. Generic Elective/Interdisciplinary **(4 Papers)**	4×4 = 16	4×5 = 20
B.2. Generic Elective Practical/ Tutorial* **(4 Papers)**	4×2 = 08	4×1 = 04
Optional Dissertation or project work in place of one Discipline Specific Elective paper (6 credits) in 6th Semester		
III. Ability Enhancement Courses **1. Ability Enhancement Compulsory**** **(2 Papers of 4 credit each)** Environmental Science/ English/ MIL Communication/Sanskrit/Hindi	2×4 = 08	2×4 = 08
2. Ability Enhancement Elective (Skill Based) (Minimum 2) **(2 Papers of 4 credit each)**	2×4 = 08	2×4 = 08
Total credit	**148**	**148**

Institute should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

**** wherever there is a practical there will be no tutorial and vice-versa., ** University/Department may add/ delete any course as per need***

3. SEMESTER-WISE COURSES AND CREDIT DISTRIBUTION (for first three years)

First Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester I								
1		Inorganic Chemistry-I: Atomic Structure & Chemical Bonding-I	SBS CH 020101 C 4004	CC	4	0	0	4
2		Physical Chemistry-I: States of Matter & Ionic Equilibrium	SBS CH 020102 C 4004	CC	4	0	0	4
3		Inorganic Chemistry Practical-I	SBS CH 020103 C 0042	CC	0	0	4	2
4		Physical Chemistry Practical-I	SBS CH 020104 C 0042	CC	0	0	4	2
5		From the list of courses (To be offered to other Department students)		GE*	4	0	0	4
6		From the list of courses (To be offered to other Department students)		GE*	0	0	4	2
7		From the list of courses		AECC	4	0	0	4
					Total Credit 22			
Semester II								
1		Organic Chemistry-I: Basics & Hydrocarbons	SBS CH 020201 C 4004	CC	4	0	0	4
2		Physical Chemistry-II: Thermodynamics & its Applications	SBS CH 020202 C 4004	CC	4	0	0	4
3		Organic Chemistry Practical-I	SBS CH 020203 C 0042	CC	0	0	4	2
4		Physical Chemistry Practical-II	SBS CH 020204 C 0042	CC	0	0	4	2
5		From the list of courses (To be offered to other Department students)		GE*	4	0	0	4
6		From the list of courses (To be offered to other Department students)		GE*	0	0	4	2
7		From the list of courses		AECC	4	0	0	4
					Total Credit 22			

CC = Core Course; GE = Generic Elective Course; AECC = Ability Enhancement Compulsory Course*

** The students of Integrated B.Sc. M.Sc. (Chemistry) programme will opt the GE courses offered by other departments of the University*

Second Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester III								
1		Inorganic Chemistry-II: s and p-Block Elements	SBS CH 020301 C 4004	CC	4	0	0	4
2		Organic Chemistry-II: Oxygen Containing Functional Groups	SBS CH 020302 C 4004	CC	4	0	0	4
3		Physical Chemistry-III: Phase Equilibria & Chemical Kinetics	SBS CH 020303 C 4004	CC	4	0	0	4
4		Inorganic Chemistry Practical-II	SBS CH 020304 C 0042	CC	0	0	4	2
5		Organic Chemistry Practical-II	SBS CH 020305 C 0042	CC	0	0	4	2
6		Physical Chemistry Practical-III	SBS CH 020306 C 0042	CC	0	0	4	2
7		From the list of courses (To be offered to other Department students)		GE*	4	0	0	4
8		From the list of courses (To be offered to other Department students)		GE*	0	0	4	2
9		From the list of courses		SEC	4	0	0	4
					Total Credit 28			
Semester IV								
1		Inorganic Chemistry-III: Coordination Chemistry	SBS CH 020401 C 4004	CC	4	0	0	4
2		Organic Chemistry-III: Heterocyclic Chemistry	SBS CH 020402 C 4004	CC	4	0	0	4
3		Physical Chemistry-IV: Electrochemistry	SBS CH 020403 C 4004	CC	4	0	0	4
4		Inorganic Chemistry Practical-III	SBS CH 020404 C 0042	CC	0	0	4	2
5		Organic Chemistry Practical-III	SBS CH 020405 C 0042	CC	0	0	4	2
6		Physical Chemistry Practical-IV	SBS CH 020406 C 0042	CC	0	0	4	2
7		From the list of courses (To be offered to other Department students)		GE*	4	0	0	4
8		From the list of courses (To be offered to other Department students)		GE*	0	0	4	2
9		From the list of courses		SEC	4	0	0	4
					Total Credit 28			

CC = Core Course; GE = Generic Elective Course; SEC = Skill Enhancement Course. (Students may choose any one from the given list). *The students of Integrated B.Sc. M.Sc. (Chemistry) programme will opt the GE courses offered by other departments of the University.*

Third Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester V								
1		Organic Chemistry-IV: Biomolecules	SBS CH 020501 C 4004	CC	4	0	0	4
2		Physical Chemistry-V: Quantum Chemistry & Spectroscopy	SBS CH 020502 C 4004	CC	4	0	0	4
3		Organic Chemistry Practical-IV	SBS CH 020504 C 0042	CC	0	0	4	2
4		Physical Chemistry Practical-V	SBS CH 020505 C 0042	CC	0	0	4	2
5		Discipline Specific Elective -1		DSE	4	0	0	4
6		Discipline Specific Elective -2		DSE	4	0	0	4
7		Discipline Specific Elective Practical-1		DSE	0	0	4	2
8		Discipline Specific Elective Practical-2		DSE	0	0	4	2
					Total Credit 24			
Semester VI								
1		Inorganic Chemistry-IV:	SBS CH 020601 C 4004	CC	4	0	0	4
2		Organic Chemistry-V:	SBS CH 020602 C 4004	CC	4	0	0	4
3		Inorganic Chemistry Practical-IV:	SBS CH 020604 C 0042	CC	0	0	4	2
4		Organic Chemistry Practical-V:	SBS CH 020605 C 0042	CC	0	0	4	2
5		Discipline Specific Elective -3		DSE	4	0	0	4
6		Discipline Specific Elective -4		DSE	4	0	0	4
7		Discipline Specific Elective Practical-3		DSE	0	0	4	2
8		Discipline Specific Elective Practical-4		DSE	0	0	4	2
					Total Credit 24			

CC = Core Course; DSE = Discipline Specific Elective Course (Students may choose any one from the given list).

Total Credit (for 03 Years) = 148

NOTE:

i. **MOOC courses (SWAYAM) having similarity more than 75% with the core course may be offered to the students. For elective courses (whatever nomenclature may be used), the students may opt from the MOOC courses provided these courses are not in the list of core course (SWAYAM) keeps changing, the departmental committee is authorized to finalize the list of MOOC courses for each semester based on the above criteria.**

ii. **Scheme and Syllabi for Fourth and Fifth Year (M.Sc.) are yet to be finalized.**

LIST of COURSES

Core Papers (C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Inorganic Chemistry I: Atomic Structure & Chemical Bonding (4 + 4)
2. Physical Chemistry I: States of Matter & Ionic Equilibrium (4 + 4)
3. Organic Chemistry I: Basics and Hydrocarbons (4 + 4)
4. Physical Chemistry II: Chemical Thermodynamics and its Applications (4 + 4)
5. Inorganic Chemistry II: s- and p-block Elements (4 + 4)
6. Organic Chemistry II: Oxygen Containing Functional Groups (4 + 4)
7. Physical Chemistry III: Phase Equilibria and Chemical Kinetics (4 + 4)
8. Inorganic Chemistry III: Coordination Chemistry (4 + 4)
9. Organic Chemistry III: Heterocyclic Chemistry (4 + 4)
10. Physical Chemistry IV: Electrochemistry (4 + 4)
11. Organic Chemistry IV: Biomolecules (4 + 4)
12. Physical Chemistry V: Quantum Chemistry & Spectroscopy (4 + 4)
13. Inorganic Chemistry IV: Organometallic Chemistry (4 + 4)
14. Organic Chemistry V: Spectroscopy (4 + 4)

Discipline Specific Elective Papers: (Credit: 06 each) (4 papers to be selected): DSE-1 to DSE-4

1. Applications of Computers in Chemistry (4) + Lab (4)
2. Analytical Methods in Chemistry (4) + Lab (4)
3. Molecular Modelling & Drug Design (4) + Lab (4)
4. Novel Inorganic Solids (4) + Lab (4)
5. Polymer Chemistry (4) + Lab (4)
6. Research Methodology for Chemistry (5) + Tutorials (1)
7. Green Chemistry (4) + Lab (4)

8. Industrial Chemicals & Environment (4) + Lab (4)
9. Inorganic Materials of Industrial Importance (4) + Lab (4)
10. Instrumental Methods of Analysis (4) + Lab (4)
11. Dissertation

Note: University/Department may include more options or delete some from this list.

Other Discipline (Four papers of any discipline, Credit: 06 each): GE-1 to GE-4

1. Mathematics (5) + Tut (1)
2. Physics (4) + Lab (4)
3. Computer Science (4) + Lab (4)/ Any other discipline of importance

Ability Enhancement Courses (AEC):

a) Ability Enhancement Compulsory Courses (Credit: 04 each):

1. English/MIL Communication/ Sanskrit/Hindi
2. Environmental Science

b) Skill Enhancement Courses (02 to 04 papers) (Credit: 04 each): SEC-1 to SEC-4

1. IT Skills for Chemists
2. Basic Analytical Chemistry
3. Chemical Technology & Society
4. Chemoinformatics
5. Business Skills for Chemists
6. Intellectual Property Rights
7. Analytical Clinical Biochemistry
8. Green Methods in Chemistry
9. Pharmaceutical Chemistry
10. Chemistry of Cosmetics & Perfumes
11. Pesticide Chemistry
12. Fuel Chemistry
13. Youth & Social Responsibilities
14. SMART Youth of Young India

Note:

1. University/Department may include more options or delete some from this list.
2. The courses will be offered according to faculty strength and as per availability of faculty members.
3. The entry and exit in the programme will be according to the relevant university ordinance.

Generic Elective Papers (GE) (Minor-Chemistry)

(any four) for other Departments/ Disciplines: (Credit: 06 each)

1. Atomic Structure, Bonding, General Organic Chemistry, Aliphatic Hydrocarbons (4 +4)
2. Chemical Energetics, Equilibria and Functional Organic Chemistry - I (4 + 4)
3. Solutions, Phase Equilibria, Conductance, Electrochemistry, & Functional Group Organic Chemistry - I (4 + 4)
4. Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics (4 + 4)
5. Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons & UV, IR Spectra (4 + 4)
6. Quantum Chemistry, Spectroscopy & Photochemistry (4 + 4)
7. Molecules of Life (4 + 4)
8. Chemistry of Main Group Elements, Theories of Acids & Bases (4 + 4)

Note:

1. University/Department may include more options or delete some from this list.
2. The courses will be offered according to faculty strength and as per availability of faculty members.

8. COURSES

<table>
<tr><td>Course No:</td><td colspan="3">Course Name:
Inorganic Chemistry-I: Atomic Structure & Chemical Bonding-I</td><td colspan="4">Course Code:
SBS CH 020101 C 4004</td></tr>
<tr><td rowspan="2">Batch:
2021 Onwards</td><td rowspan="2">Programme:
Integrated B.Sc.-M.Sc. Chemistry</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs. per Week: 04</td></tr>
<tr><td>I</td><td>4</td><td>0</td><td>0</td><td>4</td><td>Total Hrs.: 60</td></tr>
<tr><td colspan="3">Total Evaluation Marks: 100

CIE: 30 Marks

TEE: 70 Marks</td><td colspan="5">Examination Duration: 3 Hrs.

Pre-requisite of course: Basic knowledge about atomic structure, chemical bonding, periodic properties and redox reactions.</td></tr>
<tr><td>Course Objective</td><td colspan="7">To provide basic knowledge about atomic structure, quantum mechanics, dual nature of particles, bonding aspect, electrode potential etc.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the following:
CO1: Understanding about wave function
CO2: Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table
CO3: Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect.
CO4: In-depth knowledge about standard electrode potential and volumetric analysis
CO5: Ability to understand, explain predict various rules involve in chemical bonding
CO6: Understanding of anomalous behaviour of elements</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8">NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">ATOMIC STRUCTURE
Bohr’s theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg’s Uncertainty Principle and its significance, Schrödinger’s wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave</td><td>15</td></tr>
</table>

	functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s*, *p*, *d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.	
II	**PERIODICITY OF ELEMENTS** *s*, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to *s* and *p*-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio	15
III	**CHEMICAL BONDING-I** (i) *Ionic bond:* General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. (ii) *Metallic Bond:* Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids. (iii) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.	15
IV	**CHEMICAL BONDING-II AND OXIDATION-REDUCTION** *Covalent bond:* Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing	15

	lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference. Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis to be carried out in class	

Suggested Readings:

1. Atkins, P.W. & Paula, J. Physical Chemistry, 10th Edition, Oxford University Press, 2014.
2. Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
3. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
4. Douglas, B.E. and McDaniel, D.H. Concepts & Models of Inorganic Chemistry Oxford, 1970
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications, 1962.

<table>
<tr><td>Course No:</td><td colspan="3">Course Name: Physical Chemistry-I</td><td colspan="4">Course Code:
SBS CH 020102 C 4004</td></tr>
<tr><td rowspan="2">Batch:
2021
onwards</td><td rowspan="2">Programme:
Integrated B.Sc.-M.Sc. Chemistry</td><td rowspan="2">Semester:
I</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Contact Hrs. per Week: 4</td></tr>
<tr><td>4</td><td>0</td><td>2</td><td>4</td><td>Total Hrs.: 60</td></tr>
<tr><td colspan="3">Total Evaluation Marks: 100

CIE: 30 Marks

TEE: 70 Marks</td><td colspan="5">Examination Duration: 3 Hrs.

Pre-requisite of course: Knowledge of basic physical chemistry course up to Sen. Sec. level.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To provide students with a basic understanding of physical chemistry, gaseous, liquid and solid state and ionic equilibria. This course will strengthen the fundamentals of physical chemistry, especially gaseous state, liquid state and solid state.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the following:
CO1: Basic understanding of physical chemistry.
CO2: Use of gaseous, liquid and solid-state techniques in daily life.
CO3: Skills for analyzing and developing new sustainable methods.
CO4: Skills for developing industrially important methods.
CO5: Development of alternate theoretical methods.
CO6: Use of advanced and recent techniques in physical chemistry.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8">NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">GASEOUS STATE
Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.</td><td>15</td></tr>
</table>

	Behavior of real gases: Deviations from ideal gas behavior, compressibility factor, *Z*, and its variation with pressure for different gases. Causes of deviation from ideal behavior. Van der Waals equation of state, its derivation and application in explaining real gas behavior, mention of other equations of state (Berthelot, dielectric or Dieterici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.	
II	**LIQUID STATE** Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water. Different bonding present in solid and liquid state of water. Difference in structure of liquid and solid state of water.	15
III	**SOLID STATE** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.	15
IV	**IONIC EQUILIBRIA** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.	15

	Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.	

Suggested Readings:

1. P. W. Atkins, and J. D. Paula, Atkin's Physical Chemistry, 10th Edition, *Oxford University Press* (2014).
2. T. Engel, and P. Reid, Physical Chemistry 3rd Edition, *Pearson* (2013).
3. R. G. Mortimer, Physical Chemistry 3rd Edition, *Elsevier,* NOIDA, UP (2009).
4. D. W. Ball, Physical Chemistry, *Thomson Press*, India (2007).
5. G. W. Castellan, Physical Chemistry 4th Edition, *Narosa Publication House* (2004).

<table>
<tr><td>Course No:</td><td colspan="3">Course Name:
Inorganic Chemistry Practical-I</td><td colspan="4">Course Code:
SBS CH 020103 C 0042</td></tr>
<tr><td rowspan="2">Batch:
2021
onwards</td><td rowspan="2">Programme:
Integrated B.Sc.-M.Sc. Chemistry</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Contact Hrs. per Week: 04</td></tr>
<tr><td>I</td><td>0</td><td>0</td><td>4</td><td>2</td><td>Total Hrs.: 60</td></tr>
<tr><td colspan="2" rowspan="2">Total Evaluation Marks: 50

CIE: 15 Marks

TEE: 35 Marks</td><td colspan="6">Examination Duration: 6 Hrs.</td></tr>
<tr><td colspan="6">Pre-requisite of course: Skill to handle preparation of various solutions, estimation of metal ions in the sample during performing experiments.</td></tr>
<tr><td>Course Objective</td><td colspan="7">To acquire the skills to know about titrimetric analysis, acid-base titrations and oxidation-reduction titrimetry during the experiments. Also to carry out separation of mixtures of inorganic compounds by different methods.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the following:
CO1: Basic knowledge of inorganic preparation
CO2: Preparation of various solutions
CO3: Separation of ions from the mixtures
CO4: Estimation of ions from the mixtures
CO5: Knowledge about indicators
CO6: To work-up, isolate and purify, determine the purity of the prepared compound</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8">NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">TITRIMETRIC ANALYSIS
(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants
ACID-BASE TITRATIONS
(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents</td><td>35</td></tr>
<tr><td>III</td><td colspan="6">OXIDATION-REDUCTION TITRIMETRY
(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.</td><td>25</td></tr>
</table>

Suggested Readings:

1. J . Mendham, A. I. Vogel's *Quantitative Chemical Analysis 6th Edition,* Pearson, 2009.

<table>
<tr><td>Course No:</td><td colspan="3">Course Name:
Physical Chemistry Practical-I</td><td colspan="4">Course Code:
SBS CH 020104 C 0042</td></tr>
<tr><td rowspan="2">Batch:
2021 onwards</td><td rowspan="2">Programme:
Integrated B.Sc.-M.Sc. Chemistry</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credit</td><td>Contact Hrs. per Week:</td></tr>
<tr><td>I</td><td>0</td><td>0</td><td>4</td><td>2</td><td>Total Hrs.: 60</td></tr>
<tr><td colspan="3">Total Evaluation Marks: 50

CIE: 15 Marks

TEE: 35 Marks</td><td colspan="5">Examination Duration: 6 Hrs.

Pre-requisite of course: Knowledge of solution preparation, safety measure in chemistry practical laboratory and basic practical knowledge up to Sen. Sec. level.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To provide students with a basic understanding of laboratory techniques. This course will strengthen the fundamentals of analytical chemistry, and basics of physical chemistry practical techniques.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After completing this course, student is expected to learn the following:
CO1: Basic understanding of physical chemistry practical.
CO2: Use of surface tension, viscosity and indexing techniques in daily life.
CO3: Skills for analyzing and developing new sustainable methods.
CO4: Skills for developing industrially important practical methods.
CO5: Development of alternate testing methods.
CO6: Use of advanced and recent techniques in experimental chemistry.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td colspan="8">NOTE: Depending on availability of time and equipment’s, some experiments may be added/ deleted.</td></tr>
<tr><td>Unit No.</td><td colspan="6">Contents</td><td>Contact Hrs.</td></tr>
<tr><td>I</td><td colspan="6">Surface tension and Viscosity Measurements.
a. Determine the surface tension by (i) drop number (ii) drop weight method.
b. Study the variation of surface tension of detergent solutions with concentration.
c. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and(iii) sugar at room temperature.
d. Study the variation of viscosity of sucrose solution with the concentration of solute.</td><td>30</td></tr>
<tr><td>II</td><td colspan="6">Indexing by powder diffraction method of a cubic crystalline system.
a. Finding Miller indices of unknown XRD using JCPDS card file.
b. Determination of average particle size using Scherrer equation.
pH metry
a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
b. Preparation of buffer solutions of different pH</td><td>30</td></tr>
</table>

	i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base. d. Determination of dissociation constant of a weak acid.	

Suggested Readings:

1. R. Gupta, Practical Physical Chemistry, *New Age International Pub. House*, New Delhi (2017).
2. B. D. Khosla, V. C. Garg, and A . Gulati, Senior Practical Physical Chemistry, *R. Chand & Co.*, New Delhi (2011).
3. C. W. Garland, J. W. Nibler, and D. P. Shoemaker, Experiments in Physical Chemistry, 8th Edition; *McGraw-Hill,* New York (2003).
4. A. M. Halpern, and G. C. Mc. Bane, Experimental Physical Chemistry 3rd Edition, *W.H. Freeman & Co.,* New York (2003).

Course No:	Course Name: Organic Chemistry-I: Basics & Hydrocarbons				Course Code: SBS CH 020201 C 4004		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.** **Pre-requisite of course:** Basic knowledge of chemical structures of the simple organic compounds.					
Course Objective	*To provide basic knowledge of organic chemistry, reactions such as addition reactions, elimination and substitution reactions, stereochemistry and basic chemistry of alkanes, alkenes, alkynes and aromatic hydrocarbons , cycloalkanes and conformational analysis.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Thorough knowledge of basics of organic chemistry **CO2**: Basic understanding of stereochemistry **CO3**: Basic chemistry of alkanes and alkenes **CO4**: Ability to understand, explain and predict various aspects of cycloalkanes and conformational analysis.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**BASICS OF ORGANIC CHEMISTRY** Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.	15

	Formulae representation: Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions;	
II	**STEREOCHEMISTRY** Isomerism: Types of isomerism, Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Diastereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations. Cycloalkanes and Conformational Analysis: Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.	15
III	**ALKANES AND ALKENES** Carbon-Carbon sigma bonds**:** Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity. Carbon-Carbon pi bonds**:** Formation of alkenes and alkynes by elimination reactions Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.	15
IV	**ALKYNES AND AROMATIC HYDROCARBONS** Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes. Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.	15

Suggested Readings:

1. J. Singh, L.D.S. Yadav, Organic Chemistry (Volume I), 14th Edition, Pragati Prakashan, 2019.
2. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition. (Revised by S. P. Singh and Om Prakash). TRINITY Press, An Imprint of Laxmi Publications Pvt. Ltd., 2015.
3. R. N. Boyd, R. T. Morrison and S. K. Bhattcharjee, Organic Chemistry, 7thEdition, Pearson, 2014.
4. S. M. Mukerji, S. P. Singh, K.P. Kapoor and R. Das, Organic Chemistry (Volume III), 2nd Edition, New Age International Publishers, 2014.
5. J. E. McMurry, Fundamentals of Organic Chemistry, 7thEdition, Cengage Learning India, 2013.
6. S. M. Mukerji, S. P. Singh, K.P. Kapoor and R. Das, Organic Chemistry (Volume II), 2nd Edition, New Age International Publishers, 2012.
7. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume I), 2nd Edition, New Age International Publishers, 2010.
8. P. S. Kalsi, Stereochemistry Conformation and Mechanism, New Age International, 2005.
9. I. L. Finar, Organic Chemistry (Volume 1), 6th Edition, Pearson, 2002.
10. I. L. Finar, Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), 5th Edition, Pearson, 2002.
11. E. L. Eliel & S. H. Wilen, Stereochemistry of Organic Compounds, Wiley: London, 1994.

Course No:	Course Name: Physical Chemistry-II				Course Code: SBS CH 020202 C 4004		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 4** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** **3** Hrs. **Pre-requisite of course:** Knowledge of basic physical chemistry course up to Sen. Sec. level.					
Course Objectives	*To provide students with a basic understanding of chemical thermodynamics, and chemical equilibrium. This course will strengthen the fundamentals of thermodynamics, especially chemical thermodynamics, and chemical equilibrium.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of chemical thermodynamics. **CO2**: Use of chemical thermodynamics in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important chemical methods. **CO5**: Development of alternate physical chemistry methods. **CO6**: Use of advanced and recent chemical thermodynamic chemistry.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**CHEMICAL THERMODYNAMICS-I** Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics. *First law:* Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. *Second Law:* Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. *Third Law:* Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.	15

II	**SYSTEMS OF VARIABLE COMPOSITION and CHEMICAL THERMODYNAMICS-II** Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases. **CHEMICAL THERMODYNAMICS-II** *Thermochemistry:* Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature. *Free Energy Functions:* Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.	15
III	**CHEMICAL EQUILIBRIUM** Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.	15
IV	**SOLUTIONS AND COLLIGATIVE PROPERTIES** Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.	15

Suggested Readings:

1. A. Peter, and J. Paula, Physical Chemistry 10th Edition, *Oxford University Press* (2014).
2. T. Engel, and P. Reid, Physical Chemistry 3rd Edition, *Prentice-Hall* (2012).
3. M. J. Assael, A. R. H. Goodwin, M. Stamatoudis, W. A. Wakeham, and S. Will, Commonly asked questions in thermodynamics. *CRC Press*, New York (2011).
4. I. N. Levine, Physical Chemistry 6th Edition, *Tata Mc Graw Hill* (2010).
5. C. R. Metz, 2000 solved problems in chemistry, *Schaum Series* (2006).
6. G. W. Castellan, Physical Chemistry 4th Edition, *Narosa* (2004).
7. D. A. McQuarrie, and J.D. Simon, Molecular Thermodynamics, *Viva Books Pvt. Ltd*., New Delhi (2004).

Course No:	Course Name: Organic Chemistry Practical-I				Course Code SBS CH 020203 C 0042		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **II**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 02** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.** **Pre-requisite of course:** Common understanding of chemicals.					
Course Objective	*To inculcate the common skills required for performing organic chemistry practicals like m.p. and b.p. determination, crystallization and separation of compounds by thin layer chromatography.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** About the calibration of thermometer and its uses **CO2**: Determination of b.p. and m.p. of the organic compounds purification of organic compounds **CO3:** About the use of thin layer chromatography						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt both questions.

Unit No.	Contents	Contact Hrs.
I	1. Checking the calibration of the thermometer 2. Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol c) Alcohol-Water 3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)	30
II	4.Effect of impurities on the melting point – mixed melting point of two unknown organic compounds 5.Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method) 6.Chromatography	30

	a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b. Separation of a mixture of two sugars by ascending paper chromatography c. Separation of a mixture of *o*-and *p*-nitrophenol or *o*-and *p*-aminophenol by thin layer chromatography (TLC)	

Suggested Readings:

1. B.S. Furniss ; A. J. Hannaford ; P.W.G. Smith ; A. R. Tatchell, Practical Organic Chemistry, 5th Edition., Pearson, 2012.
2. F.G. Mann & B.C. Saunders, Practical Organic Chemistry, Pearson, 2009.

Course No:	Course Name: Physical Chemistry Practical-II				Course Code: SBS CH 020204 C 0042		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** **6** Hrs. **Pre-requisite of course:** Knowledge of solution preparation, safety measure in chemistry practical laboratory and basic practical knowledge up to Sen. Sec. level.					
Course Objectives	*To provide students with a basic understanding of laboratory techniques. This course will strengthen the fundamentals of analytical chemistry, and basics of physical chemistry practical techniques.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basic understanding of physical chemistry practical. **CO2**: Use of surface tension, viscosity and indexing techniques in daily life. **CO3**: Skills for analyzing and developing new sustainable methods. **CO4**: Skills for developing industrially important practical methods. **CO5**: Development of alternate testing methods. **CO6**: Use of advanced and recent techniques in experimental chemistry.						

COURSE SYLLABUS

NOTE: Depending on availability of time and equipment's, some experiments may be added/ deleted.

Unit No.	Contents	Contact Hrs.
I	**THERMOCHEMISTRY-I** (a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization). (b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. (c) Calculation of the enthalpy of ionization of ethanoic acid. (d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.	**30**
II	**THERMOCHEMISTRY-II** (a) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.	**30**

	(b) Determination of enthalpy of hydration of copper sulphate. (c) Study of the solubility of benzoic acid in water and determination of ΔH.	

Suggested Readings:

1. R. Gupta, Practical Physical Chemistry, *New Age International Pub. House*, New Delhi (2017).
2. J. B. Yadav, Advanced Practical Physical Chemistry, *Krishana Prakashan Media, Pvt. Ltd*. (2015).
3. B.D. Khosla, V. C. Garg, and A. Gulati, Senior Practical Physical Chemistry, *R. Chand & Co*., New Delhi (2011).
4. V. D. Athawale, and P. Mathur, Experimental Physical Chemistry, *New Age International*, New Delhi (2001).
5. A. M. Halpern, and G.C. Mc Bane, Experimental Physical Chemistry 3rd Edition, *W.H. Freeman & Co.,* New York (2003).

Course No:	Course Name: Environmental Science				Course Code: EVS/ SBS EVS 0107 AECC 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I or II	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** None					
Course Objective	*To aware the students the need for sustainable development, problems of pollution, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer, loss of biodiversity and need of worldwide efforts in its conservation.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: The students will get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its conservation and development. **CO2**: The understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach. **CO3**: To know about the local environmental issues, movements and an important role to minimize the impact of these aspects. **CO4**: Knowledge about the types of pollution and pollution control.						

COURSE SYLLABUS

NOTE:

i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have four sub-parts and students need to answer any two. Each part carries three and half marks.

ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries three and half marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTIONTO ENVIRONMENTAL SCIENCES** Definition, scope and importance of the environmental science, Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.	15

II	**ECOSYSTEM** Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Ecological Pyramids-types, Ecological succession, Introduction, types, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems.	15
III	**BIODIVERSITY AND ITS CONSERVATION** Introduction – Definition, value and types: genetic, species and ecosystem diversity. Bio-geographical classification and Hot-spots of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation.	15
IV	**ENVIRONMENTAL ISSUES AND POLICIES** Definition, cause, effects and control measures of Air, Water, Soil, Marine and Noise pollution. Solid Waste Management: Causes, effects and control measures of wastes. Seventeen Sustainable Developmental Goals, Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act, Public awareness.	15

Suggested Readings:

1. D. Thangadurai, G. Ching, S. Jeyabalan, and S. Islam Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management. United States: Apple Academic Press, 2019
2. I. Khan, Forest Governance and Sustainable Resource Management. SAGE Publications. India, 2019
3. P. D. Sharma, Ecology and Environment. 13th Edition, Rastogi Publications, 2017
4. G. Cao, R. Orru, Current Environmental Issues and Challenges. 14th Edition; Springer, 2014
5. D. Ginley, D. Cahen, Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press, 2011
6. R. K. Trivedi, Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, 3rd Edition. BS Publications, 2010
7. M. C. Dash, S. P. Dash, Fundamentals of Ecology. 3rd McGraw Hill Education, 2009
8. W. P. Cunningham, M. A. Cunningham, Principles of Environment Science. Enquiry and Applications. 5th Edition. Tata McGraw Hill, New Delhi, 2008
9. J. Gibbs, L. Malcolm, J. Sterling, Problem-Solving in Conservation Biology and Wildlife Management. 2nd Edition, Wiley-Blackwell,2008
10. M. Gilbert, An Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi, 2007
11. E. P. Odum, W. Barrett, Fundamentals of Ecology. 5th Edition, Cengage Learning, 2005
12. E. Bharucha, The Biodiversity of India, Mapin Publishing, 2002

<table>
<tr><td>Course No:</td><td colspan="3">Course Name:
English Communications</td><td colspan="4">Course Code:
SBS ENG 0207 AECC 4004</td></tr>
<tr><td rowspan="2">Batch:
2021 onwards</td><td rowspan="2">Programme:
Integrated B.Sc.-M.Sc.</td><td>Semester:

I or II</td><td>L

4</td><td>T

0</td><td>P

0</td><td>Credits

4</td><td>Contact Hrs. per Week: 04
Total Hrs.: 60</td></tr>
<tr><td colspan="3">Total Evaluation Marks: 100

CIE: 30 Marks

TEE: 70 Marks</td><td colspan="4">Examination Duration: 3 Hrs.

Pre-requisite of course: None</td></tr>
<tr><td>Course Objective</td><td colspan="7">The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in the vital communication skills which should be integral to personal, social and professional interactions.</td></tr>
</table>

Course Outcomes:	After completing this course, student is expected to develop the following skills: **CO1**: Ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. **CO2**: Enhancement in effective communication. **CO3**: Various dimensions of communication skills. **CO4:** Enhancement in writing skills such as report writing, note-taking etc.

COURSE SYLLABUS

NOTE:

i i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have four sub-parts and students need to answer any two. Each part carries three and half marks.

ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries three and half marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION AND COMMUNICATION** Introduction: Theory of Communication, Types and modes of Communication Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication.	15
II	**SPEAKINGSKILLS** Speaking Skills: Monologue, Dialogue, Group Discussion, Effective Communication/ Mis-Communication, Interview, Public Speech	15
III	**READINGANDUNDERSTANDING** Reading and Understanding, Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa), Literary/Knowledge Texts	15
IV	**WRITINGSKILLS** Writing Skills, Documenting, Report Writing, Making notes, Letter writing	15

Suggested Readings:

1. O. Blackswan, Language, Literature and Creativity, 2013.
2. Business English, Pearson, 2008.
3. Fluency in English-Part II, Oxford University Press, 2006.
4. Dr. G. Mishra, Dr. R. Kaul and Dr. B. Biswas, Language through Literature (forthcoming) Edition.

Course No:	Course Name: Sanskrit				Course Code: SBS SKT 0209 AECC 4004		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I or II	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.** **Pre-requisite of course:** None					
Course Objective/ □□□□□□□□□□	**1.** □□□□□□□□□□□-□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□; **2.** □□□□□□□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□-□□□□□□□□□□□□□□□□□□□ □ □□□□□□□□□□□□□□□; **3.** □□□□□□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□ □□□□□□□□ □□□□□□□□□□ □□□□□□□□□□□ □ □□□□□□□-□□□□□□□□□ □□□□□; **4.** □□□□□□□□-□□□□□□□□□□□□□□□□□ □□□□□□□□					
Course Outcomes/ □□□□□□□□□ □□□□□□□□□□ □ □□□□	After completing this course, student is expected to develop the following skills: **CO1**: □□□□□□□□□□ □□□□□□□-□□□□□□□□□□□□□□□□□□□□ □ □□□□□□□□□□ □□□□□□□□□ □□□□□□□□□□ □□□□□□□□□□□□□ □□□□□□□□ **CO2**: □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□□□ □□□□□□□ □□□□□□□□□□□□□□□ □□□□□□□□□□□□□□□□□□□- □□□□□□□□□□□□ □□□□□□□□□□□ □□□□□ □□□□□□□□□□ □□□□□□□ **CO3**: □□□□□□□□□□□□–□□□□□–□□□□□□□□□□□□–□□□□□□□□□□□□□□□□□□□ □□□□□□□□□ □□□□□□□□□□□□□□□□□□□□ □□□□□□□□□□□ □□□□□□□□□□ □□□□□□□ □□□□□□□□□ **CO4:** □□□□□□□-□□□□□□□□□□□□□□□□□□ □□□□□□□□□ □□□□□□□□□□ □□□□□□□□□□□ □□□□□□□□□□□□□□□□□ □□□□□□□□□					

□□□□□□□□□□

□□□□□□□□□□ □□□□□□□□□□□□ □□□□□□□□□□ □ □□□□□□□□ □□□□□□□□□□□□□□□ –

NOTE:

i i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have four sub-parts and students need to answer any two. Each part carries three and half marks.

ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries three and half marks.

Unit No.	Contents	Contact Hrs.
I	□□□□□-**1**: **(□)** □□□□□□□□□□ **(34. 1-6)**-□□□□□□□□□□□□□□□□□□□□; **(□)** □□□□□□□□□□□□□□□□□ - □□□□□□□□□□□□ **(□□□□□□□□□□□□□□□□)**	15
II	□□□□□-**2**:	15

	□□□□□□□□□- □□□□□□□□□ : **1-50** □□□□□□□	
III	□□□□□-**3**: □□□□□□□□□ – □□□□□□□□□□□□ **(**□□□□□□□□**)**	15
IV	□□□□□-**4**: □□□□□□□□□□□□□□□□□□□□□- **(**□**)** □□□□□□□□, □□□□□□□□□ □□□□□□□□□□□□□□□□ □□□□□□□□□□□; (□) □□□□□□□□□□□□□□□ □□□□□□□□□ □□□□□□, □□□□□□□□□□□□□□□□ □□□□□□□□, □□□□□□□□□□□□□□□ □□□□□□□□ □	15

□□□□□□□□□□□□□□□□ **-**

1. □□□□□-□□□□□, □□□□□□□□□□□□□□□□□□□□, □□□□□□□□ □□□□□□□□□□, □□□□□□, **2007**

2. □□□□□□□ □□□□□□□□ □□□□□□□□, □□□□□□□□□□□□□□□, □□□□□□□ □□□□□□□□□□□ □□□□□□□□□, □□□□□□□ □□□□□ □□□□□□□, □□□□□□□ **(**□□□□□□□□**)**

3. □□□□□□□□□□□□□□□□□, □□□□□□□ □□□□□□□□□□□□ **-** □□□□□□□ □□□□□□ □□□□□□□□□□□□ □□□□□□□□, □□□□, **2013**

4. □□□□□□□□□, □□□□□□□□, □□□□□□□□ □□□□ □□□□□□□ □□□□□□□□□□□□□ **-** □□□□□□□□ □□□□□□□□□ □□□□□□□□, □□□□□□□□ □□□□□□□□□□, □□□□□□□, **2014**

5. □□□□□□□□□□, '□□□□□□□' □□□□□□□ □□□□□□□□□□□□□ **-** □□□□□□□□□ □□□□□□□□□ □□□□□□□□□□□, □□□□□□□□, □□□□□□□□

6. □□□□□□□□□□□□□□□□□ **(**□□□□□□□ □□□□□□□ □□□□□**)**, □□□□□ □□□□□□, □□□□□□□□, **2015**

7. □□□□□□□□□□ □□□□□□□□□, □□□□□□□□□□□□□□□□□□ **(**□□□□□□□□, □□□□□□ □□□□ □□□□□□□ □□□□□□□**)**, 2005

8. □□□□□□□□□ □□□□□□, □□□□□□□ □□ □□□□□□□□ □□□□□, □□□□□□□□ □□□□□□□□ □□□□□□□, □□□□□□□□□, **1990**

9. □□□□□□□□ □□□□□□□□□, □□□□□-□□□□□□□□ □□□□ □□□□□-□□□□□□□□, □□□□□□□□□□□□□□□ □□□□□□□□, □□□, □□□□□□□□, **2012**

10. □□□□□□□□□, □□□□□□□□□□□□□, □□□□□□□□ □□□□□□□, □□□□□

11. Burrow, T., The Sanskrit Language, 2016

12. Gune, P.D., An Introduction to Comparative Philology, Oriental Book House, Poona, 1958

13. The Taittirīya Upaniṣad, Eng. Tr. and Commentary by Swami Muni Narayana Prasad, D.k. Print world (P), Ltd., New Delhi-2009

14. The Nīti and Vairāgya śatakas of Bhartrihari, M.R. Kale, Motilal Banarsidass, Delhi, 2017

Semester III

Course No:	**Course Name:** Inorganic Chemistry-II: s and p- Block Elements				**Course Code:** SBS CH 020301 C 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Idea of metallurgy, HSAB principle, chemistry of s and p Block Elements, inorganic polymers, occurrence and uses of noble gases.					
Course Objectives	*To provide students with basic understanding of* Principles of metallurgy, concept of acid-base reactions, Chemistry of s and p Block Elements, occurrence and nature of bonding in noble gas compounds.						

Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of principles of metallurgy **CO2:** Understanding the concept of acid-base reactions **CO3:** Understanding the basic properties of elements of s and p Block **CO4:** Understanding of occurrence and nature of bonding in noble gas compounds **CO5:** Understanding the Types of inorganic polymers **CO6:** Scope of inorganic compounds/polymers

COURSE SYLLABUS

NOTE:

i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.

ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**GENERAL PRINCIPLES of METALLURGY** Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.	15
II	**ACIDS AND BASES** Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.	15
III	**CHEMISTRY OF S AND P BLOCK ELEMENTS** Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens. Synthesis, structural aspects and applications of silicones and siloxanes, borazines, silicates and phosphazenes, and polysulphates.	15
IV	**NOBLE GASES** Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).	15

Suggested Readings:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B. E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth- Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Rodger, G.E. *Inorganic and Solid-State Chemistry*, Cengage Learning India Edition, 2002.
6. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
7. Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

Course No:	**Course Name:** Organic Chemistry-II: Oxygen Containing Functional Groups				**Course Code:** SBS CH 020302 C 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE: 30** Marks **TEE: 70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Chemistry of halogenated hydrocarbons, preparation and properties of alcohols, phenols, ethers and epoxides, addition reactions of carbonyl compounds, carboxylic acids and their derivatives, Sulphur containing compounds					
Course Objectives	*To provide students with basic understanding of* chemistry of halogenated hydrocarbons, preparation and properties of alcohols, phenols, ethers and epoxides, structure reactivity and preparation of carbonyl compounds, carboxylic acids and their derivatives, preparation and reactions of Sulphur containing compounds						

Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of chemistry of halogenated hydrocarbons **CO2:** Understanding of preparation and properties of alcohols, phenols, ethers and epoxides **CO3:** Understanding of addition reactions of carbonyl compounds **CO4:** Understanding the preparation, physical properties and reactions of carboxylic acids **CO5:** Understanding the preparation and reactions of Sulphur containing compounds **CO6:** Scope of organic reactions

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**CHEMISTRY OF HALOGENATED HYDROCARBONS** Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination. Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.	15
II	**ALCOHOLS, PHENOLS, ETHERS AND EPOXIDES** Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement; Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism; Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides with alcohols, ammonia derivatives and $LiAlH_4$	15

III	**CARBONYL COMPOUNDS** Structure, reactivity and preparation. Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α- substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	15
IV	**CARBOXYLIC ACIDS AND THEIR DERIVATIVES** Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids; Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.	15

Suggested Readings:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
4. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.

Course No:	**Course Name:** Physical Chemistry-III				**Course Code:** SBS CH 020303 C 4004		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** **4**	**T** **0**	**P** **0**	**Credit** **4**	**Contact Hrs. per Week:** **4** **Total Hrs.:** **60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.**					
		Pre-requisite of course: Knowledge of basic physical chemistry course up to Sen. Sec. level.					

Course Objectives	*To provide students with a basic understanding of phase equilibria, chemical kinetics, and surface chemistry. This course will strengthen the fundamentals of equilibria, especially phase equilibria and kinetics of chemical reactions.*
Course Outcomes:	After completing this course, the student is expected to learn the following: **CO1:** Basic understanding of the concept of phases and phase diagrams. **CO2:** Learn about binary solutions. **CO3:** Have an understanding of rate law and rate of reaction. **CO4:** Understanding theories of reaction rate and catalysis. **CO5:** Use of surface chemistry

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and a half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**PHASE EQUILIBRIA I** Concept of phases, components, and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour, and solid-vapour equilibria, the phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. Three-component systems, water-chloroform-acetic acid system, triangular plots.	**15**
II	**PHASE EQULIBRIA II** *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	**15**
III	**CHEMICAL KINETICS** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions, and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates.	**15**
IV	**CATALYSIS AND SURFACE CHEMISTRY**	**15**

	Types of catalyst, specificity, and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Physical adsorption, Chemisorption, adsorption isotherms (Langmuir and Freundlich), nature of the adsorbed state, and Qualitative discussion of BET.	

Suggested Readings:

1. Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked* Questions in Thermodynamics. CRC Press: NY (2011).
6. Zundhal, S.S. Chemistry concepts and applications Cengage India (2011).
7. Ball, D. W. *Physical Chemistry* Cengage India (2012).
8. Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).
9. Levine, I. N. *Physical Chemistry 6th Ed.*, Tata McGraw-Hill (2011).
10. Metz, C. R. *Physical Chemistry 2nd Ed.*, Tata McGraw-Hill (2009).

Course No:	**Course Name:** Inorganic Chemistry Practical-II				**Course Code:** SBS CH 020304 C 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Iodo / iodimetric titrations, inorganic preparations					

Course Objectives	*To provide students with basic understanding of* Iodo / iodimetric titrations, preparation of inorganic compounds
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of Estimation of ions by Iodimetrically / iodometrically **CO2:** Understanding of Preparation of inorganic compounds **CO3:** Learn Inorganic chemistry through experiments

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**IODO / IODIMETRIC TITRATIONS** (i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically). (ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically (iii) Estimation of available chlorine in bleaching powder iodometrically.	30
II	**INORGANIC PREPARATIONS** (i) Cuprous Chloride, Cu_2Cl_2 (ii) Preparation of Manganese(III) phosphate, $MnPO_4.H_2O$ (iii) Preparation of Aluminium potassium sulphate $KAl(SO_4)_2.12H_2O$ (Potash alum) or Chrome alum.	30

Suggested Readings:
1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

Course No:	**Course Name:** Organic Chemistry Practical-II				**Course Code:** SBS CH 020305 C 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week:** **04** **Total Hrs.:** **60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks	**Examination Duration:** 3 Hrs. **Pre-requisite of course:** functional group tests, preparation of Organic compounds						

Course Objectives	*To provide students with basic understanding of* functional group tests, preparation of Organic compounds
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group. **CO2:** Understanding of preparation of inorganic compounds **CO3:** Learn organic chemistry through experiments

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**FUNCTIONAL GROUP TESTS** for alcohols, phenols, carbonyl and carboxylic acid group.	30
II	**ORGANIC PREPARATIONS** i. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method: a. Using conventional method. b. Using green approach ii. Benzolyation of one of the following amines (aniline, o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (β-naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction. iii. Oxidation of ethanol/ isopropanol (Iodoform reaction). iv. Bromination of any one of the following: a. Acetanilide by conventional methods b. Acetanilide using green approach (Bromate-bromide method) v. Nitration of any one of the following: a. Acetanilide/nitrobenzene by conventional method b. Salicylic acid by green approach (using ceric ammonium nitrate). vi. Selective reduction of meta dinitrobenzene to m-nitroaniline. vii. Reduction of p-nitrobenzaldehyde by sodium borohydride. viii. Hydrolysis of amides and esters. ix. Semicarbazone of any one of the following compoundsacetone, ethyl methyl ketone, cyclohexanone, benzaldehyde. x. S-Benzylisothiouronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid). xi. Aldol condensation using either conventional or green method. xii. Benzil-Benzilic acid rearrangement.	30

	The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.	

Suggested Readings:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

Course No:	**Course Name:** Physical Chemistry Practical-III				**Course Code:** SBS CH 020306 C 0042		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** **0**	**T** **0**	**P** **4**	**Credit** **2**	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 50 **CIE: 15 Marks** **TEE: 35 Marks**		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Knowledge of solution preparation and safety measure in a chemistry practical laboratory.					

Course Objectives	*To inculcate the common skills required for performing simple Physical Chemistry Practical.*
Course Outcomes:	After completing this course, the student is expected to learn the following: **CO1:** Basic understanding of practical physical chemistry. **CO2:** Use of adsorption in daily life. **CO3:** Analyzing the kinetics of the chemical reaction. **CO4:** Use of pH meter **CO5:** Use of advanced and recent techniques in experimental chemistry.

COURSE SYLLABUS

NOTE: Depending on the availability of time and equipment, some experiments may be added/deleted.

Unit No.	Contents	Contact Hrs.
I	**PHASE EQUILIBRIA AND KINETICS** (a) Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it. (b) Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: (i) Simple eutectic and (ii) Congruently melting systems. (c) Distribution of acetic/ benzoic acid between water and cyclohexane. (d) Study the kinetics of the following reactions. 1. Initial rate method: Iodide-persulphate reaction 2. Integrated rate method: a. Acid hydrolysis of methyl acetate with hydrochloric acid. b. Saponification of ethyl acetate.	**30**
II	**ADSORPTION AND pH METRY TITRATION** Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal. Perform the following pH metric titrations i. Strong acid vs weak base ii. Weak acid vs weak base	**30**

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Semester IV

Course No:	Course Name: Inorganic Chemistry-III: Coordination Chemistry				Course Code: SBS CH 020401 C 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic understanding of coordination chemistry, transition elements, lanthanoids and actinoids, bioinorganic chemistry					
Course Objectives	*To provide students with basic understanding of* coordination chemistry, general properties of transition elements transition elements, lanthanoids and actinoids, bioinorganic chemistry						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of coordination chemistry **CO2:** Understanding the general properties of transition elements **CO3:** Understanding the electronic configuration and magnetic properties, lanthanoids and actinoids **CO4:** Understanding of application of metal ions present in biological systems, **CO5:** Scope of inorganic compounds						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**COORDINATION CHEMISTRY** Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory. IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.	15
II	**TRANSITION ELEMENTS**	15

	General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)	
III	**LANTHANOIDS AND ACTINOIDS** Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).	15
IV	**BIOINORGANIC CHEMISTRY** Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.	15

Suggested Readings:

1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C. Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N.N. & Earnshaw A. Chemistry of the Elements, Butterworth- Heinemann, 1997.

Course No:	**Course Name:** Organic Chemistry-III: Heterocyclic Chemistry				**Course Code:** SBS CH 020402 C 4004		
Batch: 2021	**Programme:** Integrated B.Sc.-	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week:** **04**

Onwards	M.Sc. Chemistry	IV	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE: 30** Marks **TEE: 70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic understanding of nitrogen containing functional groups, polynuclear hydrocarbons, heterocyclic compounds, alkaloids, terpenes					
Course Objectives	*To provide students with basic understanding of* nitrogen containing functional groups, preparation of polynuclear hydrocarbons, introduction of heterocyclic compounds, general features of alkaloids, terpenes						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of preparation and important reactions of nitrogen containing compounds **CO2:** Understanding of preparation and structure elucidation of polynuclear hydrocarbons, **CO3:** Understanding of classification, nomenclature, structure, aromaticity in heterocyclic compounds **CO4:** Understanding the natural occurrence, general structural features of natural occurrence, general structural features of alkaloids **CO5:** Understanding the occurrence, classification, and structure elucidation of terpenes **CO6:** Scope of organic compounds						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**NITROGEN CONTAINING FUNCTIONAL GROUPS** Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.	15
II	**POLYNUCLEAR HYDROCARBONS** Reactions of naphthalene phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.	15

III	**HETEROCYCLIC COMPOUNDS** Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner- Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction. Derivatives of furan: Furfural and furoic acid.	15
IV	**ALKALOIDS** Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.	15
V	**TERPENES** Occurrence, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral and α-terpineol.	15

Suggested Readings:

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
5. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
9. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, Prajati Parakashan (2010).

Course No:	**Course Name:**	**Course Code:**
	Physical Chemistry-IV	SBS CH 020403 C 4004

Batch: 2021 Onwards	Programme: Integrated B.Sc.-M.Sc. Chemistry	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 04
			4	0	0	4	Total Hrs.: 60
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic understanding of conductance, electrochemistry, electrical & magnetic properties of atoms and molecules					
Course Objectives	*To provide students with basic understanding of* applications of conductance measurement, electrochemistry, electrical & magnetic properties of atoms and molecules						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Basic understanding of Physical Chemistry. **CO2:** Applications of Electrochemistry techniques and Polymers in daily life. **CO3:** Skills for analyzing and developing new sustainable methods. **CO4:** Skills for developing new technical methods for industrial purposes. **CO5:** Development of alternate theoretical methods. **CO6:** Use of advanced and recent techniques in physical chemistry.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**CONDUCTANCE** Arrhenius's theory of electrolytic dissociation. Conductivity, equivalent, and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water.	15
II	**ELECTROCHEMISTRY** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, application of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. The Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to	15

	different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy, and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, Quinone-hydroquinone, glass, and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers.	
III	**ELECTRICAL & MAGNETIC PROPERTIES OF ATOMS AND MOLECULES** Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment, and molecular polarizabilities and their measurements. Diamagnetism, para-magnetism, magnetic susceptibility and its measurement, molecular interpretation.	15
IV	**POLYMER: AN INTRODUCTION** Historical development of polymer chemistry. Monomers, polymers, repeating units, functionality. Nomenclature of polymers. Classification of polymers. Importance and applications of polymers – acrylic, vinyl, cellulose, fluorinated, polyethylene, and conducting polymers. Degree of polymerization and molecular weight. Concept of average molecular mass and molecular mass distribution. Number average, and weight average molecular mass.	

Suggested Readings:

1. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
2. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
3. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
4. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
5. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
6. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).
7. Atkins, P.W & Paula, J.D. Physical Chemistry, 10th Ed., Oxford University Press (2014).

Course No:	**Course Name:** Inorganic Chemistry Practical-III				**Course Code:** SBS CH 020404 C 0042		
Batch: 2021	**Programme:** Integrated B.Sc.-	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week:** **04**

Onwards	M.Sc. Chemistry	IV	0	0	4	2	**Total Hrs.:** **60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Basic understanding of gravimetric analysis of ions, preparation of inorganic compounds, chromatography of metal ions					
Course Objectives	*To provide students with basic understanding of* gravimetric analysis of ions, preparation of inorganic compounds, introduction of chromatography of metal ions						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of estimation of metal ions **CO2:** Understanding the preparation of inorganic compounds **CO3:** Understanding of chromatography of metal ions **CO4:** Scope of inorganic compounds						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**GRAVIMETRIC ANALYSIS** i. Estimation of nickel (II) using Dimethylglyoxime (DMG). ii. Estimation of copper as CuSCN iii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$. iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).	30
II	**CHROMATOGRAPHY AND INORGANIC PREPARATIONS:** i. Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$ ii. *Cis* and *trans* $K[Cr(C_2O_4)_2.(H_2O)_2]$ Potassium dioxalatodiaquachromate (III) iii. Tetraamminecarbonatocobalt (III) ion iv. Potassium tris(oxalate)ferrate(III) Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)	30

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.*, Pearson, 2009.

Course No:	Course Name:	Course Code:
	Organic Chemistry Practical-III	SBS CH 020405 C 0042

Batch: 2021 Onwards	Programme: Integrated B.Sc.-M.Sc. Chemistry	Semester: IV	L	T	P	Credits	Contact Hrs. per Week: 04
			0	0	4	4	Total Hrs.: 60

Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks	**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Basic understanding of detection of extra elements, functional group test for nitro, amine and amide groups, qualitative analysis of unknown organic compounds

Course Objectives	*To provide students with basic understanding of* detection of extra elements, functional group test for nitro, amine and amide groups, qualitative analysis of unknown organic compounds
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of detection of extra elements **CO2:** Understanding of qualitative analysis of unknown organic compounds **CO3:** Scope of organic compounds

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**FUNCTIONAL GROUP TEST** Functional group test for Nitro, amine and amide groups. Detection of extra elements	30
II	**QUALITATIVE ANALYSIS** Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)	30

Suggested Readings:

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

Course No:	Course Name: Physical Chemistry Practical-IV				Course Code: SBS CH 020406 C 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Basic understanding of conductometry and potentiometry,					
Course Objectives	*To provide students with basic understanding of* conductometry and potentiometry,						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of determination of cell constant and equivalent conductance **CO2:** Titration handlings by using a potentiometer and conductivity meter. **CO3:** Skill development for qualitative and quantitative analysis.						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**CONDUCTOMETRY** I. Determination of cell constant II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid. III. Perform the following conductometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Mixture of strong acid and weak acid vs. strong base iv. Strong acid vs. weak base	30
II	**POTENTIOMETRY** I Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base	30

	iv. Potassium dichromate vs. Mohr's salt	

Suggested Readings:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H. Freeman & Co.: New York (2003).

Note:

1. Students may be encouraged or may opt courses which are available online (SWAYAM, MOOCS etc.).

List of Skill Enhancement Courses

Sr. No.	Name of the course	Course Code	L/P	T	P	Credits
1	Basic Analytical Chemistry	SBS CH 020301 SE 4004	4	0	0	**4**
2	Chemistry of Cosmetics & Perfumes	SBS CH 020302 SE 4004	4	0	0	**4**
3	Cheminformatics	SBS CH 020303 SE 4004	4	0	0	**4**
4	Pharmaceutical Chemistry	SBS CH 020304 SE 4004	4	0	0	**4**
5	Intellectual Property Rights	SBS CH 020405 SE 4004	4	0	0	**4**
6	Pesticide Chemistry	SBS CH 020406 SE 4004	4	0	0	**4**
7	Analytical Clinical Biochemistry	SBS CH 020407 SE 4004	4	0	0	**4**

Note:

2. University/Department may include more options or delete some from this list.
3. The courses will be offered according to faculty strength and as per availability of faculty members.

Course No:	Course Name: Basic Analytical Chemistry				Course Code: SBS CH 020301 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Knowledge of analytical methods in Chemistry, and different techniques used in the research laboratory.					
Course Objectives	*To skill students in analytical methods, types, proper selection of analytical methods in research and their applications*						
Course Outcomes:	After completing this course, a student is expected to learn the following: **CO1:** Understanding of prospects of analytical techniques **CO2:** Understanding of different analytical techniques **CO3:** Understanding how to apply different analytical techniques **CO4:** Understanding the properties of compounds and structure and properties based on analytical techniques. **CO5:** Understanding the basics of different analytical techniques. **CO6:** Understanding of different separation techniques						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and a half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**QUALITATIVE AND QUANTITATIVE ASPECTS OF ANALYSIS** Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q, and t-test, rejection of data, and confidence intervals. Origin of spectra, the interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.	15
II	**OPTICAL METHODS OF ANALYSIS** *UV-Visible spectrometry:* Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument.	15

	Infrared spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instruments; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.	
III	**THERMAL METHODS OF ANALYSIS** Theory of thermogravimetry (TG), Basic principle of instrumentation of TGA/DTA and DSC. Techniques for quantitative estimation of Ca and Mg from their mixture. Applications of TGA/DTA in analysis of the sample.	15
IV	**Electroanalytical methods** Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pK_a values. Polarography: An introduction, principle, instrumentation, and applications.	15

Suggested Readings:

1. Mendham, J., A. I. Vogel's (2009) Quantitative Chemical Analysis *6th Ed.*, Pearson.
2. Willard, H.H. *et al.* (1988) Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company: Belmont, California, USA.
3. Christian, G.D. (2004) Analytical Chemistry, 6th Ed. John Wiley & Sons: New York.
4. Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. & Nieman, T.A. (1979) Principles of Instrumental Analysis, Cengage Learning India Ed.
7. Mikes, O. (2008) Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons.
8. Ditts, R.V. (1974) Analytical Chemistry; Methods of separation, van Nostrand.

Course No:	Course Name: Chemistry of Cosmetics and Perfumes				Course Code: SBS CH 020302 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basics understanding of Chemistry					
Course Objectives	*To provide a basic knowledge of the chemistry of cosmetics, the major ingredients present in most cosmetics include water, emulsifiers, preservatives, thickeners, moisturizers, dyes and fragrances.*						
Course Outcomes:	After completing this course, student is expected to to provide general overview on cosmetics and perfumes. This course has been designed to impart the theoretical and practical knowledge on basic principles of cosmetic chemistry, manufacture, formulation of various cosmetic products.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**BASICS** **Cosmetics-** Definition, History, Classification, Ingredients, Nomenclature, Regulations. **Face Preparation:** Structure of skin, Face powder, Compact powder, Talcum powder. **Skin Preparation:** Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream.	15
II	**HAIR PREPARATION** Structure of hair, classification of hair, Hair dye- classification – temporary, semi-permanent, demi-permanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners.	15
III	**COLORED PREPARATION** Nail preparation Structure of nail, Nail lacquers, Nail polish remover Lipsticks. **Personal hygiene products:** Antiperspirants and deodorants, oral hygiene products, flavors, and essential oils.	15

IV	**ESSENTIAL OILS AND ITS INDUSTRIAL APPLICATIONS** Essential oils and their importance in cosmetic industries with reference to Eugenol, Geraniol, sandalwood oil, eucalyptus, rose oil, 2-phenyl ethyl alcohol, Jasmone, Civetone, Muscone.	15

Suggested Readings:

1. Stocchi, E. Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK (1990).
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut, (1996).Cooper, T.G. *Tool of Biochemistry*. Wiley-Blackwell (1977).

Course No:	Course Name: Cheminformatics				Course Code: SBS CH 020303 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Knowledge of computer aided support in Chemistry, related softwares.					
Course Objectives	*To skill students about chemoinformatics, nomenclature, reaction classification, proper searching of chemical structures and its applications*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of prospects of chemoinformatics **CO2:** Understanding of nomenclature and reaction classification **CO3:** Understanding on how to search chemical structure **CO4:** Understanding the properties of compounds and structure and property relations **CO5:** Understanding the computational chemistry in elucidation of structure and design of synthesis **CO6:** Understanding of drug design, target identification and optimization						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION TO CHEMOINFORMATICS** History, Prospects of chemoinformatics, Molecular Modelling and Structure elucidation.	15
II	**REPRESENTATION OF MOLECULES AND CHEMICAL REACTIONS** Nomenclature, Different types of notations, SMILES coding, Matrix representations, Structure of Molfiles and Sdfiles, Libraries and toolkits, Different electronic effects, Reaction classification.	15
III	**SEARCHING CHEMICAL STRUCTURES** Full structure search, sub-structure search, basic ideas, similarity search, three dimensional search methods, basics of computation of physical and chemical data and structure descriptors, data visualization.	15

IV	**APPLICATIONS** Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Model Building; Modelling. Toxicity; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra; Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Target Identification and Validation; Lead Finding and Optimization; Analysis of HTS data; Virtual Screening; Design of Combinatorial Libraries; Ligand and structure based drug design; Applications in Drug Design.	15

Suggested Readings:

1. Andrew R. Leach and Valerie, J. Gillet, An introduction to Chemoinformatics. Springer: The Netherlands (2007).
2. Gasteiger, J. and Engel, T. Chemoinformatics: A text-book. Wiley-VCH (2003).
3. Gupta, S. P. QSAR & Molecular Modeling. Anamaya Pub.: New Delhi (2011).

Course No:	Course Name: Pharmaceutical Chemistry				Course Code: SBS CH 020304 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic understanding of non-covalent interactions, biomolecules and biochemical processes					
Course Objectives	*This course will provide a basic understanding and fundamentals of pharmaceutical chemistry, drug discovery and development process, different classes of drugs and its mechanism of action. This course will develop skills in the preparation and development of new lead compounds and their modification towards drug discovery.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** To understand basic knowledge of pharmaceutical chemistry of various classes of drugs and their mechanism of action as well as synthesis. **CO2:** An appreciation of the history of medicinal and pharmaceutical chemistry, understanding of basic biochemical functioning of living organisms, structural and functional details of bio-macromolecules such as proteins, nucleic acids and lipids. **CO3**: Advanced knowledge about Sympathomimetic Drugs and its uses. **CO4**: Strategies and tactics of development of various Psychoactive agents. Examples with synthesis. **CO5**: Basic concepts of fermentation and its applications.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**DRUGS AND PHARMACEUTICALS** Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir).	15
II	**PSYCHOACTIVE DRUGS**	15

	Central Nervous System agents (Phenobarbital, Diazepam), Antidepressant Drugs (Amitriptyline, Nortryptyline, Imperamine, Phepelzine, Tranylcypromine), Steroidal Drugs (Betamethasone, Cortisone, Hydrocortisone, Prednisolone, Progesterone, Testosterone, Oestradiol, Nandrolone), Tranquilizers (Chlorpromazine, Prochlorperazine, Trifluoperazine, Thiothixene, Haloperiodol, Triperiodol, Oxypertine, Chlordizepoxide, Diazepam, Lorazepam, Meprobamate)	
III	**SYMPATHOMIMETIC DRUGS** Adrenergic drugs (Adrenaline, Noradrenaline, Isoprenaline, Phenylephrine, Salbutamol, Terbutaline, Ephedrne, Pseudoephedrine), Adrenergic antagonist (Tolazoline, Propranolol, Practolol), Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine),	15
IV	**FERMENTATION** Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	15

Suggested Readings:

1. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK, 2013.
2. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012
3. Foye, W.O., Lemke, T.L. & William, D.A.: Principles of Medicinal Chemistry, 4th ed., B.I. Waverly Pvt. Ltd. New Delhi.
4. Government of India, Ministry of Health. (1955). Pharmacopoeia of India:(the Indian pharmacopoeia). Delhi:Manager of Publications
5. Pharmaceutical Society of Great Britain. (19071973). British pharmaceutical codex.London :Pharmaceutical press.
6. Martindale: The extra pharmacopeia, 28th Ed. Edited By James E. F. Reynolds and Anne B. Prasad. The Pharmaceopeial Press, 1 Lamberth High Street, London, SE1 7JN

Course No:	Course Name: Intellectual property Rights				Course Code: SBS CH 020405 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Knowledge of intellectual property rights, and copyrights.					
Course Objectives	*To skill students about intellectual property rights, copyrights, international agreements, patents, and patent filing.*						
Course Outcomes:	After completing this course, a student is expected to learn the following: **CO1:** Understanding of prospects of patent filling **CO2:** Understanding of Copyrights **CO3:** Understanding Trademarks **CO4:** Understanding the different international agreements **CO5:** Understanding the Paris convention **CO6:** Understanding the difference between trademark copyright and patent.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION TO INTELLECTUAL PROPERTY** Historical Perspective, Different Types of IP, Importance of protecting IP. **Copyrights** Introduction, How to obtain, Differences from Patents. **Trade Marks** Introduction, How to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.	15
II	**PATENTS** Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India. **Geographical Indications**	15

	Definition, rules for registration, prevention of illegal exploitation, importance to India. **Industrial Designs** Definition, How to obtain, features, International design registration.	
III	**DIFFERENT INTERNATIONAL AGREEMENTS** **(a) Word Trade Organization (WTO):** (i) General Agreement on Tariffs & Trade (GATT), Trade Related Intellectual Property Rights (TRIPS) agreement (ii) General Agreement on Trade-related Services (GATS) (iii) Madrid Protocol (iv) Berne Convention (v) Budapest Treaty	15
IV	**PARIS CONVENTION** **WIPO** and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity **IP Infringement issue and enforcement** – Role of Judiciary, Role of law enforcement agencies – Police, Customs, etc. Economic Value of Intellectual Property – Intangible assets and their valuation, Intellectual Property in the Indian Context – Various laws in India Licensing and technology transfer.	15

Suggested Readings:

1. Acharya, N.K. (2001) Textbook on intellectual property rights, Asia Law House.
2. Guru, M. & Rao, M.B. (2003) U nderstanding Trips: Managing Knowledge in Developing Countries, Sage Publications.
3. Ganguli, P. (2001) Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill.
4. Miller, A.R. & Davis, M.H. (2000) Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers.
5. Watal, J. (2008) Intellectual property rights in the WTO and developing countries, Oxford University Press, New Delhi.

Course No:	Course Name: Pesticide Chemistry				Course Code: SBS CH 020406 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic knowledge of chemistry and pesticides					
Course Objectives	*To offer recognition as a chemist with understanding of various pesticides with respect to synthesis of pesticides, their formulations development and analysis of physico-chemical properties.*						
Course Outcomes:	After completing this course, student is expected **CO1:** To learn to understand chemistry of pesticide and their formulations **CO2:** They will be able to apply the fundamental knowledge of pest control methods including IPM **CO3:** Gain knowledge about and various agrochemicals **CO4:** Gain knowledge about botanicals and bio-pesticides **CO5:** Different ways of their formulations and analysis of pesticides.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION** General introduction to pesticides (natural and synthetic), benefits and adverse effects, changing concepts of pesticides, structure activity relationship, synthesis and technical manufacture and uses of representative pesticides in the following classes: Organochlorines (DDT, Gammexene,); Organophosphates (Malathion, Parathion); Carbamates (Carbofuran and carbaryl); Quinones (Chloranil), Anilides (Alachlor and Butachlor).	15
II	**IMPORTANT EXAMPLES FROM EACH CHEMICAL CLASS** Pyrethroids – Alphamethrin, Lambda – cyhalothrin, Biphenthrin, Inorganic Compounds: Inorganic Fungicides – Sulphur, Copper Salts; Inorganic fumigant – hydrogen cyanide ; Inorganic rodenticides – Zinc phosphides; Herbicides – Imidazolinones, Dimetholin, Sulphonyl Urea, Dinitroaniline, Butachlor, Trifluralin, Auxadiazines; Organo-tin compounds.	15

III	**APPLICATIONS AND ITS ENVIRONMENTAL IMPACTS** Role of IPR in pesticides development, Pesticides formulations : Purpose ; Adjuvants; Application of formulations; Wettable and flowable powders; Emulsions; Emulsifiable concentrates; Aqueous suspension; Solution Concentrates; Dust; Aerosol; Granules; Slow release granules; Baits; Modern safer formulations verses earlier formulations, Health hazards and environmental impacts of residential pesticides.	15
IV	**PHENYL PYRAZOLE AND ITS CHEMISTRY** Phenyl pyrazole – new class of chemistry; Endosulphan; Chlopyriphos; Carbamyl; Alphamethrin, Biological control of Pests.	15

Suggested Readings:

1. Cremlyn, R. *Pesticides. Preparation and Modes of Action*, John Wiley & Sons, New
2. York, 1978.
3. Thomas A. Unger, Pesticide Synthesis Handbook, Prochrom Industrias Quimicas S/A Elsevier, 1996.
4. Roberts TR, Robert, Hutson DH, Jewess PJ, editors. Metabolic pathways of agrochemicals: insecticides and fungicides. Royal Society of Chemistry; 1998.
5. S. K. Handa, Principles of Pesticide Chemistry, Ed. By Agrobios (India) ISBN 9788177542165, 2008.
6. Vyas SC. Handbook of Systemic Fungicides: Compounds. Tata McGraw-Hill; 1993.
7. Zweig G. Analytical methods for pesticides, plant growth regulators and food additives Vol. I –XVII.
8. Matolcsy G, Nádasy M, Andriska V. Pesticide chemistry. Elsevier; 1989

Course No:	Course Name: Analytical Clinical Biochemistry				Course Code: SBS CH 020407 SE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Basic understanding of the structures, properties and functions of biomolecules					
Course Objectives	It will introduce the student the structure and function of biomolecules, and understand the chemical principles in life processes. Classification, disorders related to overproduction and underproduction of hormones are also emphasized in this paper						
Course Outcomes:	After completing this course, student is expected **CO1:** To understand the structure and metabolic process **CO2:** Understand biomolecules **CO3:** Gain knowledge about regulation in metabolic pathways **CO4:** Understand disorders of metabolic pathways						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION TO CARBOHYDRATES AND LIPIDS** Carbohydrates: Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides. Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications. Lipoproteins, Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.	15
II	**PROTEINS AND ENZYMES : IMPORTANCE AND REGULATION**	15

	Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins. Enzymes: Nomenclature, classification, Characteristics (mention of Ribozymes), Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry. effect of pH, temperature on enzyme activity, enzyme inhibition.	
III	**NUCLEIC ACIDS** Structure of DNA (Watson-Crick model) and RNA, Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation, Introduction to Gene therapy.	15
IV	**BIOCHEMISTRY OF DISEASE : A DIAGNOSTIC APPROACH BY BLOOD/URINE ANALYSIS** Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin. Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.	15

Suggested Readings:

1. Cooper, T.G. *Tool of Biochemistry.* Wiley-Blackwell (1977).
2. Wilson, K. & Walker, J. *Practical Biochemistry.* Cambridge University Press (2009).
3. Devlin, T.M., *Textbook of Biochemistry with Clinical Correlations*, John Wiley & Sons, 2010.
4. Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
5. Talwar, G.P. & Srivastava, M. *Textbook of Biochemistry and Human Biology*, 3rd Ed. PHI Learning.
6. Nelson, D.L. & Cox, M.M. *Lehninger Principles of Biochemistry*, W.H. Freeman, 2013.

List of GE Courses To Be Offered To The Other Departments

Sr. No.	Name of the course	Course Code	L	T	P	Credits
1	GE: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	SBS CH 020101 GE 4004	4	0	0	**4**
2	GE-Lab: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons	SBS CH 020102 GE 0042	0	0	4	**2**
3	GE: Chemical Energetics, Equilibria & Functional Organic Chemistry-I	SBS CH 020201 GE 4004	4	0	0	**4**
4	GE Lab: Chemical Energetics, Equilibria & Functional Organic Chemistry-I	SBS CH 020202 GE 0042	0	0	4	**2**
5	Solutions, Phase Equilibria, Conductance, Electrochemistry, & Functional Group Organic Chemistry-II	SBS CH 020301 GE 4004	4	0	0	**4**
6	GE Lab: Solutions, Phase Equilibria, Conductance, Electrochemistry, & Functional Group Organic Chemistry-II	SBS CH 020302 GE 0042	0	0	4	**2**
7	GE: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics	SBS CH 020303 GE 4004	4	0	0	**4**
8	GE Lab: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics	SBS CH 020304 GE 0042	0	0	4	**2**
9	Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons & UV, IR Spectra	SBS CH 020401 GE 4004	4	0	0	**4**
10	GE Lab: Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons & UV, IR Spectra	SBS CH 020402 GE 0042	0	0	4	**2**

11	GE: Quantum Chemistry, Spectroscopy & Photochemistry	SBS CH 020403 GE 4004	4	0	0	**4**
12	GE Lab: Quantum Chemistry, Spectroscopy & Photochemistry	SBS CH 020404 GE 0042	0	0	4	**2**
13	Molecules of Life	SBS CH 020405 GE 4004	4	0	0	**4**
14	GE Lab: Molecules of Life	SBS CH 020406 GE 0042	0	0	4	**2**
15	Chemistry of Main Group Elements, Theories of Acids & Bases	SBS CH 020407 GE 4004	4	0	0	**4**
16	GE Lab: Chemistry of Main Group Elements, Theories of Acids & Bases	SBS CH 020408 GE 0042	0	0	4	**2**

Note:

1. University/Department may include more options or delete some from this list.
2. The courses will be offered according to faculty strength and as per availability of faculty members.

Course No:	Course Name: GE: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons				Course Code: SBS CH 020101 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** None					
Course Objective	*To provide basic knowledge of fundamentals of inorganic chemistry and organic chemistry to the students.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: The wave function **CO2**: Structures and geometries of molecules using Radius Ratio Rules, VSEPR theory and MO diagrams **CO3**: Importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect **CO4:** The nature and behavior of organic compounds **CO5:**Mechanisms of several organic reactions including free radical/electrophilic substitution/addition **CO6:** The fundamental concepts of stereochemistry						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
	INORGANIC CHEMISTRY-1	
I	**ATOMIC STRUCTURE** Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.	14

	What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distance with special reference to 1*s* and 2*s* atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_l and m_s. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Discovery of spin, spin quantum number(*s*) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.	
II	**CHEMICAL BONDING AND MOLECULAR STRUCTURE** **Ionic Bonding:** General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. **Covalent Bonding:** VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. **MO Approach:** Rules for the LCAO method, bonding and antibonding MOs and their characteristics for *s-s*, *s-p* and *p-p* combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of *s-p* mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+. Comparison of VB and MO approaches.	16
	ORGANIC CHEMISTRY-1	
III	**FUNDAMENTALS OF ORGANIC CHEMISTRY** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.	16

	Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule. **Stereochemistry**: Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis-trans* nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).	
IV	**ALIPHATIC HYDROCARBONS** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes:** (Upto 5 Carbons) Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. **Alkynes**: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$	14

Suggested Readings:

1. J. Singh, L.D.S. Yadav, Organic Chemistry (Volume I), 14th Edition, Pragati Prakashan, 2019.
2. T.W. Graham Solomon, C.B. Fryhle, & S.A. Dnyder, Organic Chemistry, John Wiley & Sons, 2014.
3. J.E. McMurry, Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning Edition, 2013.
4. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume I), 2nd Edition, New Age
5. International Publishers, 2010.
6. R.T. Morrison & R.N. Boyd, Organic Chemistry, Pearson, 2010.

A. Bahl, & B.S. Bahl, S. Chand, Advanced Organic Chemistry, 2010.

7. J.E. Huheey, E.A. Keiter, R.L. Keiter, & O.K. Medhi, Inorganic Chemistry: Principles of Structure and
8. Reactivity, Pearson Education India, 2006.
9. E.L. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
10. F.A. Cotton, G. Wilkinson, & P.L. Gaus, Basic Inorganic Chemistry, 3rd Edition, Wiley, 1995.
11. J.D. Lee, Concise Inorganic Chemistry ELBS, 1991.
12. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi 1988.
13. Cotton, F.A., Wilkinson, G. & Gaus, P.L., Basic Inorganic Chemistry, 3rd Edition, Wiley, 1995.
14. Finar, I.L. Organic Chemistry (Volume I & II), E.L.B.S.,1988.

Course No:	Course Name: GE-Lab: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons				Course Code: SBS CH 020102 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I	**L**	**T**	**P**	**Credit**	**Contact Hrs. per Week: 04**
			0	0	4	2	**Total Hours: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.** **Pre-requisite of course:** None					
Course Objective	*To inculcate the common skills required for performing simple inorganic and organic chemistry practicals.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** The estimation techniques by volumetric analysis **CO2**: The handling skills of simple chemicals, glassware and small equipment. **CO3:** The qualitative analysis of simple organic compounds						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	***INORGANIC CHEMISTRY*** **VOLUMETRIC ANALYSIS** i. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. ii. Estimation of oxalic acid by titrating it with $KMnO_4$. iii. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$. iv. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator. v. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.	30
II	***ORGANIC CHEMISTRY*** **QUAILITATIVE ANALYSIS OF ORGANIC COMPOUNDS** i. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements).	30

	ii. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given) (a) Identify and separate the components of a given mixture of two amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography. (b) Identify and separate the sugars present in the given mixture by paper chromatography.	

Suggested Readings:

1. G. Svehla, Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. J. Mendham, Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. A.I. Vogel, Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th Edition, 1996.
4. F.G. Mann, & B.C. Saunders, Practical Organic Chemistry Orient-Longman, 1960.

Course No:	Course Name: GE: Chemical Energetics, Equilibria & Functional Organic Chemistry-I				Course Code: SBS CH 020201 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.**					
		Pre-requisite of course: None					
Course Objective	*To provide basic knowledge of chemistry of aromatic hydrocarbons, alky and aryl halides, alcohols, phenols, ethers and carbonyl compounds. To provide basic understanding of chemical energetics, chemical equilibrium and ionic equilibria.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basics of chemical energetics. **CO2**: Basics of chemical equilibrium and ionic equilibria. **CO3**: Chemistry of aromatic hydrocarbons, alky and aryl halides. **CO4**: Chemistry of alcohols, phenols, ethers and carbonyl compounds.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
	PHYSICAL CHEMISTRY-1	
I	**CHEMICAL ENERGETICS** Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.	15

II	**CHEMICAL EQUILIBRIUM AND IONIC EQUILIBRIA:** Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^{o}, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases. Ionic Equilibrium: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle	15
	ORGANIC CHEMISTRY-2	
III	**AROMATIC HYDROCARBONS** *Preparation* (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. *Reactions*: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene). **ALKYL AND ARYL HALIDES** Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions. *Preparation:* from alkenes *and* alcohols. *Reactions:* hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution. Aryl Halides *Preparation:* (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.	15
IV	**ALCOHOLS, PHENOLS AND ETHERS (UPTO 5 CARBONS)** Alcohols: *Preparation:* Preparation of 1^{o}, 2^{o} and 3^{o} alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. *Reactions:* With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation *Diols:* (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement. Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.	15

	Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction. Ethers (aliphatic and aromatic): Cleavage of ethers with HI. Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde) *Preparation:* from acid chlorides and from nitriles. *Reactions* – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.	

Suggested Readings:

1. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, Revised Edition. (Revised by S. P. Singh and Om Prakash). TRINITY Press, An Imprint of Laxmi Publications Pvt. Ltd., 2015.
2. T.W. Graham Solomon, C.B. Fryhle, & S.A. Dnyder, Organic Chemistry, John Wiley & Sons, 2014.
3. J.E. McMurry, Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
4. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume II), 2nd Edition, New Age International Publishers, 2010.
5. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume I), 2nd Edition, New Age International Publishers, 2010.
6. I.L. Finar, Organic Chemistry (Volume I & II), E.L.B.S.
7. R.T. Morrison, & R.N. Boyd, Organic Chemistry, Pearson, 2010.
8. A. Bahl, & B.S Bahl, S. Chand, Advanced Organic Chemistry, 2010.
9. J.C. Kotz, P.M Treichel, & J.R. Townsend, General Chemistry Cengage Learning India Pvt. Ltd., New Delhi, 2009.
10. G.M. Barrow, Physical Chemistry, Tata McGraw-Hill, 2007.
11. G.W. Castellan, Physical Chemistry, 4th Edition, Narosa, 2004.
12. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi, 1988.
13. B.H Mahan, University Chemistry, 3rd Edition, Narosa, 1998.
14. R.H. Petrucci, General Chemistry, 5th Edition, Macmillan Publishing Co.: New York, 1985.

Course No:	Course Name: GE Lab: Chemical Energetics, Equilibria & Functional Organic Chemistry-I				Course Code: SBS CH 020202 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** II	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.** **Pre-requisite of course:** None					
Course Objective	*To acquire the skills for handling reactions to prepare simple organic compounds. To provide knowledge about the purification techniques for organic compounds and their m.pt determination to the students. To explain the importance and applications of thermochemistry and to calculate the pH of the different solutions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Thermochemistry and its applications in chemistry **CO2**: Ionic equilibria and measurement of pH of different solutions. **CO3:** Purification techniques and their importance **CO4:** Single-step organic preparations and purification of the obtained product						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**PHYSICAL CHEMISTRY** **Thermochemistry** 1. Determination of heat capacity of calorimeter for different volumes. 2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3. Determination of enthalpy of ionization of acetic acid. 4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl). 5. Determination of enthalpy of hydration of copper sulphate. 6. Study of the solubility of benzoic acid in water and determination of ΔH. **Ionic equilibria** pH measurements Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter. a) Preparation of buffer solutions:	30

	(i) Sodium acetate-acetic acid (ii)Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.	
II	**ORGANIC CHEMISTRY** 1. Purification of organic compounds by crystallization (from water and alcohol) and distillation. 2. Criteria of Purity: Determination of melting and boiling points. 3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done. (a) Bromination of Phenol/Aniline (b) Benzoylation of amines/phenols (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone	30

Suggested Readings:

1. B.D. Khosla ; V . C . Garg & A. Gulati Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. A.L. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford & P.W.G. Smith Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
3 F.G. Mann & B.C. Saunders Practical Organic Chemistry Orient-Longman, 1960.

Course No:	Course Name: GE: Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-Ii				Course Code: SBS CH 020301 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.**					
		Pre-requisite of course: Basic understanding of solutions, phase equilibria, basic organic reactions.					
Course Objective	*To provide students with basic concept of different types of binary solutions, phase equilibria, conductance, and organic reactions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Explain the concepts of different types of binary solutions-miscible, partially miscible and immiscible along with their applications **CO2**: Explain the thermodynamic aspects of equilibria between phases and draw phase diagrams of simple one component and two component systems **CO3**: Explain the factors that affect conductance, migration of ions and application of conductance measurement **CO4:** Understand different types of galvanic cells, their Nernst equations, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements **CO5:** Understand and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses **CO6:** Design newer synthetic routes for various organic compounds						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**SOLUTIONS AND PHASE EQUILIBRIA** **Solutions** Thermodynamics of ideal solutions: Ideal solutions and Raoult's law, deviations from Raoult's law – non-ideal solutions. Vapour pressure-composition and temperature-	**15**

	composition curves of ideal and non-ideal solutions. Distillation of solutions. Lever rule. Azeotropes. Partial miscibility of liquids: Critical solution temperature; effect of impurity on partial miscibility of liquids. Immiscibility of liquids- Principle of steam distillation. Nernst distribution law and its applications, solvent extraction. **Phase Equilibria** Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics, congruent and incongruent melting points (lead-silver, $FeCl_3$-H_2O and Na-K only).	
II	**CONDUCTANCE AND ELECTROCHEMISTRY** **Conductance** Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions. Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements: determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid- base). **Electrochemistry** Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference. Liquid junction potential and salt bridge. pH determination using hydrogen electrode and quinhydrone electrode. Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).	**15**
III	**CARBOXYLIC ACIDS AND THEIR DERIVATIVES, AMINES AND DIAZONIUM SALTS** **Carboxylic acids and their derivatives** Carboxylic acids (aliphatic and aromatic) Preparation: Acidic and Alkaline hydrolysis of esters. Reactions: Hell – Vohlard - Zelinsky Reaction. Carboxylic acid derivatives (aliphatic): (Upto 5 carbons) Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.	**15**

	Reactions: Comparative study of nucleophilicity of acyl derivatives. Reformatsky Reaction, Perkin condensation. **Amines and Diazonium Salts** Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, Hofmann Bromamide reaction. Reactions: Hofmann vs. Saytzeff elimination, Carbylamine test, Hinsberg test, with HNO_2, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation. Diazonium salts: Preparation: from aromatic amines. Reactions: conversion to benzene, phenol, dyes.	
IV	**AMINO ACIDS, PEPTIDES AND PROTEINS, AND CARBOHYDRATES** **Amino Acids, Peptides and Proteins** Preparation of Amino Acids: Strecker synthesis using Gabriel's phthalimide synthesis. Zwitterion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test. Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C- activating groups and Merrifield solid-phase synthesis. **Carbohydrates** Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.	**15**

Suggested Readings:

1. Barrow, G. M. *Physical Chemistry* Tata McGraw-Hill (2007).
2. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
4. Mahan, B. H. *University Chemistry*, 3rd Ed. Narosa (1998).
5. Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
6. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
9. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
10. Berg, J. M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

Course No:	Course Name: GE Lab: Solutions, Phase Equilibria, Conductance, Electrochemistry & Functional Group Organic Chemistry-Ii				Course Code: SBS CH 020302 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Basic understanding of transition metals, coordination chemistry, kinetic theory of gases and chemical kinetics.					
Course Objective	*To provide students with basic concept of transition/inner transition metals and bonding in coordination chemistry. Also get idea about various theories of reaction rates.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Determine distribution constant **CO2**: Determine conductance **CO3:** Understand potentiometric titrations **CO4:** Determine qualitative organic analysis						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**PHYSICAL CHEMISTRY** **Distribution** Study of the equilibrium of one of the following reactions by the distribution method: $I_2(aq) + I^-(aq) = I_3^-(aq)$ $Cu^{2+}(aq) + xNH_2(aq) = [Cu(NH_3)_x]^{2+}$ **Phase equilibria** a) Construction of the phase diagram of a binary system (simple eutectic) using cooling curves b) Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it c) Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.	30

	Conductance (i) Determination of cell constant (ii) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid (iii) Perform the following conductometric titrations: (a) Strong acid vs. strong base and (b) Weak acid vs. strong base **Potentiometry** (i) Perform the following potentiometric titrations: (ii) Strong acid vs. strong base (iii) Weak acid vs. strong base (iv) Potassium dichromate vs. Mohr's salt	
II	**ORGANIC CHEMISTRY** **I** Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative. **II** (i) Separation of amino acids by paper chromatography (ii) Determination of the concentration of glycine solution by formylation method (iii) Titration curve of glycine (iv) Action of salivary amylase on starch (v) Effect of temperature on the action of salivary amylase on starch (vi) Differentiation between a reducing and a nonreducing sugar	30

Suggested Readings:

1. Vogel, A. I.; Tatchell, A. R.; Furnis, B. S.; Hannaford, A. J.; Smith, P. W. G. *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th ed, 1996.
2. Mann, F. G.; Saunders, B. C. *Practical Organic Chemistry* Orient-Longman, 1960.
3. Khosla, B. D.; Garg, V. C.; Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
4. Ahluwalia, V. K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press (2004)

Course No:	Course Name: GE: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics				Course Code: SBS CH 020303 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.** **Pre-requisite of course:** Basic understanding of transition metals, coordination chemistry, kinetic theory of gases and chemical kinetics.					
Course Objective	*To provide students with basic concept of transition/inner transition metals and bonding in coordination chemistry. Also get idea about various theories of reaction rates.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Understand chemistry of d and f block elements **CO2**: Properties of coordination compounds **CO3**: Understanding VBT for bonding in coordination compounds **CO4:** Understanding CFT for bonding in coordination compounds **CO5:** Understand the real gases deviation from ideal behaviour **CO6:** Define rate of reactions and the factors that affect the rates of chemical reactions.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**TRANSITION ELEMENTS (3d SERIES)** General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes and stability of various oxidation states (Latimer diagrams) for Mn, Fe and Cu. Lanthanoids and actinoids: Electronic configurations, oxidation states, colour, magnetic properties, lanthanide contraction, separation of lanthanides (ion exchange method only).	**15**

II	**COORDINATION CHEMISTRY** Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, Ni and Cu (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature. **CRYSTAL FIELD THEORY** Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of D. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes, Tetragonal distortion of octahedral geometry. Jahn-Teller distortion, Square planar coordination.	**15**
III	**KINETIC THEORY OF GASES** Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Boyle temperature (derivation not required). Critical phenomena, critical constants and their calculation from van der Waals equation. Andrews isotherms of CO2. Maxwell Boltzmann distribution laws of molecular velocities and molecular energies and their importance. Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules. Viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).	**15**
IV	**CHEMICAL KINETICS** The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).	**15**

Suggested Readings:

1. Barrow, G.M. Physical Chemistry Tata McGraw-Hill, 2007.
2. Castellan, G.W. Physical Chemistry 4th Ed. Narosa, 2004.
3. Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
4. Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York, 1985.
5. Rodgers, G.E. Inorganic & Solid State Chemistry, Cengage Learning India Ltd., 2008.
6. Atkins, P. Paula, J. Atkins' Physical Chemistry, 10th Edition. Oxford University Press, 2014.

Course No:	Course Name: GE Lab: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics				Course Code: SBS CH 020304 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Basic understanding of transition metals, coordination chemistry, kinetic theory of gases and chemical kinetics.					
Course Objective	*To provide students with basic concept of transition/inner transition metals and bonding in coordination chemistry. Also get idea about various theories of reaction rates.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Analyze presence of acid and basic radicals **CO2**: Determine hardness of water **CO3:** Study reaction rates **CO4:** Measurement of surface tension and viscosity						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**INORGANIC CHEMISTRY** Semi-micro qualitative analysis (using H_2S or other methods) of mixtures - not more than two ionic species (one anion and one cation, excluding insoluble salts) out of the following: Cations : NH^{4+}, Pb^{2+}, B^{i3+}, Cu^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^{+} Anions : CO_3^{2-} , S^{2-}, SO_2^{-}, $S_2O_3^{2-}$, NO^{3-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO_3 , SO_4^{2-}, PO_4^{3-}, BO_3^{3-}, $C_2O_4^{2-}$, F^{-} (Spot tests should be carried out wherever feasible) 1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) or aluminium as oximate in a given solution gravimetrically. 2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.	30
II	**PHYSICAL CHEMISTRY** (I) Surface tension measurement (use of organic solvents excluded).	30

	a) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer. b) Study of the variation of surface tension of a detergent solution with concentration. (II) Viscosity measurement (use of organic solvents excluded). a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer. b) Study of the variation of viscosity of an aqueous solution with concentration of solute. (III) Chemical Kinetics Study the kinetics of the following reactions. 1. Initial rate method: Iodide-persulphate reaction 2. Integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid. 3. Saponification of ethyl acetate.	

Suggested Readings:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

Course No:	Course Name: GE: Organometallics, Bioinorganic Chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy				Course Code: SBS CH 020401 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.** **Pre-requisite of course:** Basic understanding of 3*d* elements, bonding aspects in organometallic compounds along with some spectroscopic parameters.					
Course Objective	*To provide students with basic concept of bonding aspects in organometallic/bioinorganic/polynuclear compounds.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Understand the chemistry and applications of 3d elements including their oxidation states and important properties of the familiar compounds potassium dichromate, potassium permanganate and potassium ferrocyanide **CO2**: Use IR data to explain the extent of back bonding in carbonyl complexes **CO3**: Get a general idea about role of metal ions present in biological systems **CO4:** Understand the fundamentals of functional group chemistry, polynuclear hydrocarbons and heterocyclic compounds through the study of methods of preparation, properties and chemical reactions with underlying mechanism **CO5:** Gain insight into the basic fundamental principles of IR and UV-Vis spectroscopic techniques **CO6:** Use basic theoretical principles underlying UV-visible and IR spectroscopy as a tool for functional group identification in organic molecules						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**CHEMISTRY OF 3*d* METALS AND ORGANOMETALLIC COMPOUNDS** **Chemistry of 3*d* metals** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties);	**15**

	Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$. **Organometallic Compounds** Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeiss salt and ferrocene. EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).	
II	**BIO-INORGANIC CHEMISTRY** A brief introduction to bio-inorganic chemistry. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump; Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).	**15**
III	**POLYNUCLEAR AND HETERONUCLEAR AROMATIC COMPOUNDS AND ACTIVE METHYLENE COMPOUNDS** **Polynuclear/heteronuclear aromatic compounds** Properties of the following compounds with reference to electrophilic and nucleophilic substitution: Naphthalene, Anthracene, Furan, Pyrrole, Thiophene, and Pyridine. **Active methylene compounds:** *Preparation:* Claisen ester condensation. Keto-enol tautomerism. *Reactions:* Synthetic uses of ethylacetoacetate (preparation of non-heteromolecules having upto 6 carbon).	**15**
IV	**APPLICATION OF SPECTROSCOPY TO SIMPLE ORGANIC MOLECULES** Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, λ_{max} & ε_{max}, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λ_{max} of conjugated dienes and α,β – unsaturated compounds.	**15**

	Infrared radiation and types of molecular vibrations, functional group and fingerprint region. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O stretching absorptions).	

Suggested Readings:

1. Huheey, J. E.; Keiter, E.; Keiter, R. *Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.
2. Miessler, G. L.; Tarr, D. A. *Inorganic Chemistry,* Pearson Publication.
3. Lee, J. D. *A New Concise Inorganic Chemistry,* E.L.B.S.
4. Cotton, F. A.; Wilkinson, G. *Basic Inorganic Chemistry*, John Wiley & Sons.
5. Finar, I. L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
6. Dyer, J. A. *Applications of Absorption Spectroscopy of Organic Compounds,* Prentice Hall.
7. Silverstein, R. M.; Bassler, G. C.; Morrill, T. C. *Spectroscopic Identification of Organic Compounds*, John Wiley & Sons.
8. Morrison, R. T.; Boyd, R. N. *Organic Chemistry,* Prentice Hall.
9. Sykes, P. *A Guide Book to Mechanism* in *Organic Chemistry,* Orient Longman.
10. Bahl, A.; Bahl, B. S. *Advanced Organic Chemistry,* S. Chand.

Course No:	Course Name: GE Lab: ORGANOMETALLICS, BIOINORGANIC CHEMISTRY, POLYNUCLEAR HYDROCARBONS AND UV, IR SPECTROSCOPY				Course Code: SBS CH 020402 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks	**Examination Duration: 6 Hrs.** **Pre-requisite of course:** Basic understanding of metal-carbon bonds, metal ions in biology, hydrocarbons and spectroscopy.						
Course Objective	*To provide students with basic concept of transition/inner transition metals and bonding in coordination chemistry. Also get idea about various spectroscopic techniques.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of metal-carbon bond in chemistry **CO2**: Importance of metal ions in biology **CO3:** Understanding of enzymes and proteins **CO4:** Synthesis of simple molecules **CO5:** And their characterizations by UV and IR spectroscopy						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**INORGANIC CHEMISTRY** 1. Separation of mixtures by chromatography: Measure the Rf value in each case. (Combination of two ions to be given) Paper chromatographic separation of Fe^{3+}, $A1^{3+}$ and Cr^{3+} or Paper chromatographic separation of Ni^{2+}, Co^{2+}, Mn^{2+} and Zn^{2+} 2. Preparation of any two of the following complexes and measurement of their conductivity: a. tetraamminecarbonatocobalt (III) nitrate b. tetraamminecopper (II) sulphate c. potassium trioxalatoferrate (III) trihydrate Compare the conductance of the complexes with that of M/1000 solution of NaCl, $MgCl_2$ and $LiCl_3$.	30
II	**ORGANIC CHEMISTRY**	30

	Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, amines) and preparation of one derivative. Characterization by UV and IR spectroscopy.	

Suggested Readings:

1. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel: Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Course No:	Course Name: GE: Quantum Chemistry, Spectroscopy & Photochemistry				Course Code: SBS CH 020403 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.**					
		Pre-requisite of course: Basic understanding of quantum mechanics, molecular spectroscopy and photochemical reactions.					
Course Objective	*To provide students with basic concept of quantum mechanics, bonding in molecules, electronic transition, quantum efficiency and photochemical processes.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions **CO2**: Understand chemical bonding in molecules **CO3**: Understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra **CO4:** Understand the fundamentals of electron spin resonance **CO5:** Understanding fundamental of photophysical phenomena **CO6:** Define rate of reactions and the factors that affect the rates of chemical reactions.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**QUANTUM CHEMISTRY** Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.	**15**

	Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy. Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component. Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.	
II	**CHEMICAL BONDING** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H^{2+}. Bonding and antibonding orbitals. Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH2 type molecules.	**15**
III	**MOLECULAR SPECTROSCOPY** Interaction of electromagnetic radiation with molecules and various types of spectra; Born- Oppenheimer approximation. Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution. Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches. Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.	**15**

	Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.	
IV	**PHOTOCHEMISTRY** Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.	**15**

Suggested Readings:

1. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi, 2006.
2. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill, 2001.
3. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA, 2004.
4. Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press, 2005.
5. Kakkar, R. Atomic & Molecular Spectroscopy: Concepts & Applications, Cambridge University Press, 2015.
6. Rohatgi, K. K. Mukherjee, K. K. Fundamentals of Photochemistry, 3rd Edition. New Age International (P) Ltd., 2014.

Course No:	Course Name: GE Lab: Quantum Chemistry, Spectroscopy & Photochemistry				Course Code: SBS CH 020404 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Knowledge of spectroscopy and colourimetry					
Course Objective	*To provide students with basic concept of quantum mechanics, bonding in molecules, electronic transition, quantum efficiency and photochemical processes.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Understand basic principles of quantum mechanics: operators, eigen values, averages, probability distributions **CO2**: Understand chemical bonding in molecules **CO3**: Understand and use basic concepts of microwave, IR and UV-VIS spectroscopy for interpretation of spectra **CO4:** Understand the fundamentals of electron spin resonance **CO5:** Understanding fundamental of photophysical phenomena **CO6:** Define rate of reactions and the factors that affect the rates of chemical reactions.						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**UV/VISIBLE SPECTROSCOPY** i) Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV). ii) Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$. iii) Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.	30
II	**COLOURIMETRY** i) Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration ii) Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.	30

	iii) Study the kinetics of iodination of propanone in acidic medium. iv) Determine the amount of iron present in a sample using 1,10-phenathroline. v) Determine the dissociation constant of an indicator (phenolphthalein). vi) Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide. vii) Analyse the given vibration-rotation spectrum of HCl(g)	

Suggested Readings:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* 8^{th} *Ed.;* McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry* 3^{rd} *Ed.;* W.H. Freeman & Co.: New York (2003).

Course No:	Course Name: GE: Molecules of Life				Course Code: SBS CH 020405 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.**					
		Pre-requisite of course: Basic understanding of biological processes.					
Course Objective	*To provide students with basic concept of* biological processes and energy in biosystem.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses **CO2**: Gain an insight into mechanism of enzyme action and inhibition **CO3**: Understand the basic principles of drug-receptor interaction and SAR **CO4:** Understand biological processes like replication, transcription and translation **CO5:** Demonstrate an understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes **CO6:** To understand concept of energy in biosystems						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**CARBOHYDRATES** Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, mutarotation and anomers. Determination of configuration of Glucose (Fischer proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.	**15**

II	**AMINO ACIDS, PEPTIDES AND PROTEINS** Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t- butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.	**15**
III	**ENZYMES AND CORRELATION WITH DRUG ACTION, AND NUCLEIC ACIDS** **Enzymes and correlation with drug action** Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecificity), Enzyme inhibitors and their importance, phenomenon of inhibition(Competitive and Non- competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure-activity relationships of drug molecules, binding role of –OH group,-NH_2 group, double bond and aromatic ring. **Nucleic Acids** Components of nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides **(nomenclature**), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (**types of RNA**), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.	**15**
IV	**LIPIDS AND CONCEPT OF ENERGY IN BIOSYSTEMS** **Lipids** Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol). **Concept of Energy in Biosystems** Calorific value of food. Standard caloric content of carbohydrates, proteins and fats.	**15**

	Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change. Conversion of food into energy. Outline of catabolic pathways of Carbohydrate-Glycolysis, Fermentation, Krebs Cycle. Overview of catabolic pathways of Fats and Proteins. Interrelationships in the metabolic pathways of Proteins, Fats and Carbohydrates.	

Suggested Readings:

1. Morrison, R. T.; Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L.; Cox, M. M. *Lehninger's Principles of Biochemistry* 7^{th} *Ed.,* W. H. Freeman.
5. Berg, J. M. Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.

Course No:	Course Name: GE Lab: Molecules of Life				Course Code: SBS CH 020406 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.** **Pre-requisite of course:** Basic understanding of paper chromatography, saponification value, titration, synthesis and Extraction of DNA from onion/cauliflower.					
Course Objective	*To provide students with basic concept of synthesis of medicinal compounds and paper chromatography. Also determination of saponification/concentration of some given sample.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** To understand paper chromatography in separation of amino acids **CO2**: Determine saponification value **CO3:** To understand extraction of DNA **CO4:** Synthesis of some medicinal compounds						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**INORGANIC CHEMISTRY** 1. Separation of amino acids by paper chromatography 2. To determine the concentration of glycine solution by formylation method. 3. Study of titration curve of glycine 4. Action of salivary amylase on starch 5. Effect of temperature on the action of salivary amylase on starch.	30
II	**ORGANIC CHEMISTRY** 1. To determine the saponification value of an oil/fat. 2. To determine the iodine value of an oil/fat 3. Differentiate between a reducing/nonreducing sugar. 4. Extraction of DNA from onion/cauliflower 5. To synthesise aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC.	30

Suggested Readings:

1. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
2. Ahluwalia, V. K.; Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

Course No:	Course Name: GE: Chemistry of Main Group Elements, Theories of Acids and Bases				Course Code: SBS CH 020407 GE 4004		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **IV**	**L** 4	**T** 0	**P** 0	**Credit** 4	**Contact Hrs. per Week: 04** **Total Hours: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.** **Pre-requisite of course:** Basic properties of acid-base and *s*/*p*-block elements.					
Course Objective	*To provide students with basic concept of* periodic properties and bonding aspects in molecules.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: To understand acid base interaction **CO2**: Gain an insight into metallurgical processes **CO3**: To understand the basic principles of periodic properties of *s*/*p*-block elements **CO4:** To understand multicentre bonding in boranes **CO5:** Understanding of inorganic polymers **CO6:** To understand concept of pseudohalides						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	**ACIDS AND BASES, GENERAL PRINCIPLES OF METALLURGY** **Acids and Bases** Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.	**15**

	General Principles of Metallurgy Chief modes of occurrence of metals based on standard electrode potentials, Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents. Hydrometallurgy with reference to cyanide process for gold and silver. Methods of purification of metals (Al, Pb, Ti, Fe, Cu, Ni, Zn, Au): electrolytic refining, zone refining, van Arkel-de Boer process, Parting Process, Mond's process and Kroll Process.	
II	***s*- AND *p*-BLOCK ELEMENTS** Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electronegativity (Pauling scale). General characteristics of *s*-block metals like density, melting and boiling points, flame colour and reducing nature. Oxidation states of *s*- and *p*-block elements, inert-pair effect, diagonal relationships and anomalous behaviour of first member of each group. Allotropy in C, P and S. Complex forming tendency of *s* block elements and a preliminary idea of crown ethers and cryptates, structures of basic beryllium acetate, salicylaldehyde/ acetylacetonato complexes of Group 1 metals. Solutions of alkali metals in liquid ammonia and their properties. Common features, such as ease of formation, solubility and stability of oxides, peroxides, superoxides, sulphates and carbonates of *s*-block metals.	**15**
III	**Structure, bonding and properties** Diborane and concept of multicentre bonding, hydrides of Groups 13 (EH_3), 14, 15, 16 and 17. Oxides of N and P, Oxoacids of P, S and Cl. Halides and oxohalides of P and S (PCl_3, PCl_5, $SOCl_2$ and SO_2Cl_2), Interhalogen compounds. A brief idea of pseudohalides	**15**
IV	**NOBLE GASES AND INORGANIC POLYMERS** **Noble gases** Rationalization of inertness of noble gases, clathrates, preparation and properties of XeF_2, XeF_4 and XeF_6 ,bonding in these compounds using VBT and shapes of noble gas compounds using VSEPR Theory. **Inorganic Polymers**	**15**

	Types of inorganic polymers and comparison with organic polymers, structural features, classification and important applications of silicates. Synthesis, structural features and applications of silicones. Borazines and cyclophosphazenes – preparation, properties and reactions. Bonding in $(NPCl_2)_3$.	

Suggested Readings:

1. Lee, J. D. *Concise Inorganic Chemistry* ELBS, 1991.
2. Cotton, F. A.; Wilkinson, G.; Gaus, P. L. *Basic Inorganic Chemistry*, 3rd ed. Wiley.
3. Douglas, B. E.; McDaniel, D. H.; Alexander, J. J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
4. Greenwood, N. N.; Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
5. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
6. Miessler, G. L.; Tarr, D. A. *Inorganic Chemistry* 4th Ed. Pearson, 2010.
7. Atkin, P.; *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press 2010.

Course No:	Course Name: GE Lab: Chemistry of Main Group Elements, Theories of Acids and Bases				Course Code: SBS CH 020408 GE 0042		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total Hrs: 60**
Total Evaluation Marks: 50 **CIE:** 15 Marks **TEE:** 35 Marks		**Examination Duration: 6 Hrs.**					
		Pre-requisite of course: Basic understanding of quantitative analysis and synthesis of some inorganic complexes.					
Course Objective	*To provide students with basic concept of iodometric estimation,* gravimetric estimation and determination of dissolved oxygen in water sample.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** To understand iodometric estimation **CO2**: To understand gravimetric estimation **CO3:** Determination of dissolved oxygen in water samples **CO4:** Synthesis of some inorganic complexes						

COURSE SYLLABUS

NOTE:
Two questions will be set, one from each of the UNIT. The candidates are required to attempt all the questions.

Unit No.	Contents	Contact Hrs.
I	**INORGANIC CHEMISTRY** 1.Iodometric estimation of potassium dichromate and copper sulphate 2.Iodimetric estimation of antimony in tartaremetic 3.Estimation of amount of available chlorine in bleaching powder and household bleaches 4. Estimation of iodine in iodized salts. 5. Iodimetric estimation of ascorbic acid in fruit juices.	30
II	**ORGANIC CHEMISTRY** 1. Estimation of dissolved oxygen in water samples. 2. Gravimetric estimation of sulphate as barium sulphate. 3. Gravimetric estimation of aluminium as oximato complex 4. Preparation of the following: potash alum, chrome alum, tetraamminecopper(II) sulphate monohydrate, potassium trioxalatoferrate(III) (any two, including one double salt and one complex).	30

Suggested Readings:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

9. TEACHING-LEARNING PROCESS

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation or Project Work
- Technology-embedded Learning
- Hands on training
- Self study analysis
- Report writing

10. IMPLEMENTATION OF BLENDED LEARNING

Blended Learning is a pedagogical approach that combines face to-face classroom methods with computer-mediated activities in the process of teaching and learning. It implies nice blend of face-to-face and online activities to make the learning processes more interesting and engaging. It focuses on integration of traditional classroom activities and innovative ICT-enabled strategies. It emphasizes student-centric learning environment where the teacher is the facilitator for productive and measurable learning outcomes. It optimizes and compliments the face to face learning, giving ample freedom and flexibility to the students and teachers to access and explore the wide range of open-access sources such as video lectures, podcasts, recordings and articles through digital platforms. It gives freedom and autonomy to the teachers in selection of appropriate digital platforms, resources and time-slots to complement and supplement face to face learning. The Blended Learning doesn't undermine the role of the teacher, rather it gives him/her an opportunity to explore the unexplored in accordance with the requirements of the curriculum.

Key features of Blended Learning

- Student-Centric Pedagogical Approach focusing on flexibility in timing, quality content, needs and interests of students and freedom to study through the mode of his/her choice;
- Freedom to Select variety of mediums and techniques;
- Increased student engagement in learning;
- Enhanced teacher and student interaction;
- Improved student learning outcomes;
- More flexible teaching and learning environment;
- More responsive for self and continuous learning;
- Better opportunities for experiential learning;
- Increased learning skills;
- Greater access to information, improved satisfaction and learning outcomes.

Note: It was resolved that Blended Learning with 40% component of online teaching and 60% face to face classes for each programme, may be adopted

11. ASSESSMENT AND EVALUATION

Overall assessment will be made as per relevant ordinances of CUH.

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired if required
- Group Examinations on Problem solving exercises

- Seminar Presentations
- Review of Literature

Collaborative Assignments

13. REFERENCES

Instructional Template for Facilitating Implementation of Choice Based Credit System (CBCS) (https://www.ugc.ac.in/pdfnews/4426331_Instructional-Template.pdf)

Scheme and Syllabi of B. Sc. Honours with chemistry (https://www.ugc.ac.in/pdfnews/6573215_B.Sc.HONOURS-CHEMISTRY.pdf**)**

Scheme and Syllabi of B. Sc. with chemistry (https://www.ugc.ac.in/pdfnews/0614691_LOCF-chemistry.pdf)

National Education Policy-2020.

https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

The draft subject specific LOCF templates available on UGC website.

https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==

Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website.

https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf

Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions (https://www.ugc.ac.in/e-book/GL%20Multipe%20Entry%20Exit/mobile/index.html)

14. APPENDICES

Curricular Reforms — Extracts from National Education Policy-2020