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)

(w.e.f. Session 2022-23)

DEPARTMENT OF CHEMISTRY
SCHOOL OF BASIC SCIENCES

Approved by :	**BOS**	**School Board**	**Academic Council**
Approval Status :	√	√	√
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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 (% 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 (AEC)	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 Course **(14 Papers)** **Core Course Practical / Tutorial*** **(14 Papers)**	14×4 = 56 14×2 = 28	14×5 = 70 14×1= 14
II. Elective Course **(8 Papers)** A.1. Discipline Specific Elective **(4 Papers)** A.2. Discipline Specific Elective Practical/Tutorial* **(4 Papers)**	4×4 = 16 4×2 = 08	4×5 = 20 4×1 = 04
B.1. Generic Elective/Interdisciplinary **(4 Papers)** B.2. Generic Elective Practical/ Tutorial* **(4 Papers)**	4×4 = 16 4×2 = 08	4×5 = 20 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	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**
University 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 include more options or delete some from this list. The courses will be offered according to faculty strength and as per availability of faculty members.**		

NOTE: 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.

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	SBS CH 020101 C 3104	CC	3	1	0	4
2		Inorganic Chemistry Practical-I	SBS CH 020102 C 0042	CC	0	0	4	2
3		Organic Chemistry-I	SBS CH 020103 C 3104	CC	3	1	0	4
4		Organic Chemistry Practical-I	SBS CH 020104 C 0042	CC	0	0	4	2
5		From the list of courses available (any one)	AEC-1		3	1	0	4
6		From the list of courses available (any one)	SEC-1		2	0	0	2
7		Offered by other Departments	GE		3	1	4	6
					Total Credit 24			
Semester II								
1		Physical Chemistry-I	SBS CH 020201 C 3104	CC	3	1	0	4
2		Physical Chemistry Practical-I	SBS CH 020202 C 0042	CC	0	0	4	2
3		Organic Chemistry-II	SBS CH 020203 C 3104	CC	3	1	0	4
4		Organic Chemistry Practical-II	SBS CH 020204 C 0042	CC	0	0	4	2
5		From the list of courses available (any one)	AEC-2		3	1	0	4
6		From the list of courses available (any one)	SEC-2		2	0	0	2
7		(Offered by other Departments	GE		3	1	4	6
					Total Credit 24			

CC = Core Course; AEC = Ability Enhancement Course; SEC = Skill Enhancement Course; GE = Generic Elective Course; (or students may choose any one from the given list)

In addition to the courses students will be trained for Seminars, Group Discussions and Individual/Team Projects throughout the semesters.

Second Year

Sr. No.	Course No.	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester III								
1		Physical Chemistry-II	SBS CH 020301 C 3104	CC	3	1	0	4
2		Physical Chemistry Practical-II	SBS CH 020302 C 0042	CC	0	0	4	2
3		Organic Chemistry-III	SBS CH 020303 C 3104	CC	3	1	0	4
4		Organic Chemistry Practical-III	SBS CH 020304 C 0042	CC	0	0	4	2
5		Molecular Spectroscopy and Photochemistry	SBS CH 020305 C 3104	CC	3	1	0	4
6		Spectroscopy Practical	SBS CH 020306 C 0042	CC	0	0	4	2
7		Offered by other Departments	GE		3	1	4	6
					Total Credit 24			
Semester IV								
1		Physical Chemistry-III	SBS CH 020401 C 3104	CC	3	1	0	4
2		Physical Chemistry Practical-III	SBS CH 020402 C 0042	CC	0	0	4	2
3		Inorganic Chemistry-II	SBS CH 020403 C 3104	CC	3	1	0	4
4		Inorganic Chemistry Practical-II	SBS CH 020404 C 0042	CC	0	0	4	2
5		Introduction to Quantum Chemistry	SBS CH 020405 C 3104	CC	3	1	0	4
6		Quantum Chemistry Practical	SBS CH 020406 C 0042	CC	0	0	4	2
7		Offered by other Departments	GE		3	1	4	6
					Total Credit 24			

CC = Core Course; AEC = Ability Enhancement Course; SEC = Skill Enhancement Course; GE = Generic Elective Course; (or students may choose any one from the given list)

In addition to the courses students will be trained for Seminars, Group Discussions and Individual/Team Projects throughout the semesters.

Third Year

Sr. No.	Course No.	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester V								
1		Inorganic Chemistry-III	SBS CH 020501 C 3104	CC	3	1	0	4
2		Inorganic Chemistry Practical-III	SBS CH 020502 C 0042	CC	0	0	4	2
3		Analytical Chemistry	SBS CH 020503 C 3104	CC	3	1	0	4
4		Analytical Chemistry Practical	SBS CH 020504 C 0042	CC	0	0	4	2
5		From the list of courses available	**SEC-3**		2	0	0	2
6		From the list of courses available	**DSE-1**		3	1	0	4
7		From the list of courses available	**Practical (DSE-1)**		0	0	4	2
8		From the list of courses available	**DSE-2**		3	1	0	4
9		From the list of courses available	**Practical (DSE-2)**		0	0	4	2
					Total Credit 26			
Semester VI								
1		Green Chemistry	SBS CH 020601 C 3104	CC	3	1	0	4
2		Green Chemistry Practical	SBS CH 020602 C 0042	CC	0	0	4	2
3		Materials Chemistry	SBS CH 020603 C 3104	CC	3	1	0	4
4		Materials Chemistry Practical	SBS CH 020604 C 0042	CC	0	0	4	2
5		From the list of courses available	**SEC-4**		2	0	0	2
6		From the list of courses available	**DSE-3**		3	1	0	4
7		From the list of courses available	**Practical (DSE-3)**		0	0	4	2
8		From the list of courses available	**DSE-4**		3	1	0	4
9		From the list of courses available	**Practical (DSE-4)**		0	0	4	2
					Total Credit 26			

CC = Core Course; SEC = Skill Enhancement Course; DSE = Discipline Specific Elective Course; (or students may choose any one from the given list)

In addition to the courses students will be trained for Seminars, Group Discussions and Individual/Team Projects throughout the semesters.

Note:

1. AEC, SEC, DSE and GE courses will be offered according to faculty strength and as per the availability of faculty members.
2. The University/Department may add/delete courses from time to time as per requirement.
3. The entry and exit in the Integrated B.Sc.-M.Sc. programme will be decided according the relevant University Ordinance.

LIST of COURSES

Core Papers (C): (Credit: 06 each) (3 periods + 1 tutorial/week for theory and 4 periods/week for practical)

1. Inorganic Chemistry I (4 + 4)
2. Organic Chemistry I (4 + 4)
3. Physical Chemistry I (4 + 4)
4. Organic Chemistry II (4 + 4)
5. Physical Chemistry II (4 + 4)
6. Organic Chemistry III (4 + 4)
7. Molecular Spectroscopy and Photochemistry (4+4)
8. Physical Chemistry III (4 + 4)
9. Inorganic Chemistry II (4 + 4)
10. Introduction to Quantum Chemistry (4 + 4)
11. Inorganic Chemistry III (4 + 4)
12. Analytical Chemistry (4 + 4)
13. Green Chemistry (4 + 4)
14. Materials Chemistry (4 + 4)

Discipline Specific Elective (DSE) Papers: (Credit: 06 each) (3 periods + 1 tutorial/week for theory and 4 periods/week for practical)

1. Medicinal Chemistry
2. Electrochemistry
3. Electrochemistry Practical
4. Advanced Analytical Chemistry
5. Organic Spectroscopy
6. Heterocyclic Chemistry
7. Organometallics and Bioinorganic chemistry
8. Introduction to Nanochemistry & applications
9. Dissertation (To be taken as optional in place of one DSE course)

Ability Enhancement (AEC) Papers: (Credit: 04 each) (3 periods + 1 tutorial/week)

1. English for Communication
2. History of Indian Science
3. Good Laboratory Practices
4. Cheminformatics
5. Research methodology
6. Chemistry in Everyday life

Skill Enhancement (SEC) Papers: (Credit: 02 each) (2 periods week)

1. Personality Development
2. Computer Applications in Chemistry
3. Science Communication and
4. Popularization
5. Biofertilizer
6. Herbal Science & Technology
7. Fermentation Science & Technology
8. Environment Impact Analysis

Generic Elective (GE) Papers: (Credit: 06 each) (3 periods + 1 tutorial/week for theory and 4 periods/week for practical)

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

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.

4. COURSES

Semester I

Course No:	Course Name: Inorganic Chemistry-I				Course Code: SBS CH 020101 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I	**L** 3	**T** 1	**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 about atomic structure, chemical bonding, periodic properties and redox reactions.					
Course Objective	*To provide basic knowledge about atomic structure, quantum mechanics, dual nature of particles, bonding aspect, electrode potential etc.*						
Course Outcomes:	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						

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	**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 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.	15
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.	15

	(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	
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 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.	15

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.

Course No:	Course Name: Inorganic Chemistry Practical-I				Course Code: SBS CH 020102 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **I**	**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:** Skill to handle preparation of various solutions, estimation of metal ions in the sample during performing experiments.					
Course Objective	*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.*						
Course Outcomes:	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						

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	**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	35
III	**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.	25

Suggested Readings:

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

Course No:	Course Name: Organic Chemistry-I				Course Code: SBS CH 020103 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. (Chemistry)	**Semester:** I	**L** 3	**T** 1	**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. Formulae representation: Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions;	15
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.	15

	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.	
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, 7th Edition, 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: Organic Chemistry Practical-I				Course Code: SBS CH 020104 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **I**	**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 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)	30

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.

Semester II

Course No:	Course Name: Physical Chemistry-I				Course Code: SBS CH 020201 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** II	**L** 3	**T** 1	**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 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.*						
Course Outcomes:	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.						

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	**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. 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	15

	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. 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.	15

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).

Course No:	Course Name: Physical Chemistry Practical-I				Course Code: SBS CH 020202 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry	**Semester:** II	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week:** **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	**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.	30
II	**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 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.	30

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-II				Course Code: SBS CH 020203 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**L** 3	**T** 1	**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 chemistry of halogenated hydrocarbons, preparation and properties of alcohols, phenols, ethers and epoxides, addition reactions of carbonyl compounds, carboxylic acids and their derivatives.					
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.*						
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 – S_N1, S_N2 and SN^i 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 and their use in synthesis.	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 substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmannbromamide degradation and Curtius rearrangement.	15

Suggested Readings:

1. Solomons, T.W G., Fryhle, B. Craig. *Organic Chemistry,* John Wiley & Sons, Inc (2009).
2. McMurry, J.E. *Fundamentals of Organic Chemistry*, Seventh edition Cengage Learning (2013).
3. P. Sykes, *A Guide Book to Mechanism in Organic Chemistry*, Orient Longman, New Delhi, 6th Edition (1997),
4. 4 Morrison R. T. and Boyd R. N. Organic Chemistry, Sixth Edition Prentice Hall India (2003).

Course No:	Course Name: Organic Chemistry Practical-II				Course Code: SBS CH 020204 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 6 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	**Identification of elements and FUNCTIONAL GROUP TESTS** Identification of elements (N, S, and halogen) and 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.	30

	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. 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).

Semester III

Course No:	Course Name: Physical Chemistry-II				Course Code: SBS CH 020301 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** III	**L** 3	**T** 1	**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**	15

	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.	
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: Physical Chemistry Practical-II				Course Code: SBS CH 020302 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L**	**T**	**P**	**Credit**	**Contact Hrs. per Week: 04**
			0	0	4	2	**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. (b) Determination of enthalpy of hydration of copper sulphate. (c) Study of the solubility of benzoic acid in water and determination of ΔH.	**30**

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: Organic Chemistry-III				Course Code: SBS CH 020303 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L** 3	**T** 1	**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 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:** Nitrogen containing functional groups and their reactions. **CO2:** Familiarization with polynuclear hydrocarbons and their reactions. **CO3:** Heterocyclic compounds and their reactions. **CO4:** Alkaloids and Terpenes **CO5:** Understanding reactions and reaction mechanism of nitrogen containing functional groups. **CO6:** Understanding the reactions and mechanisms of diazonium compounds.						

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	**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 AND TERPENES** 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. 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: Organic Chemistry Practical-III				Course Code: SBS CH 020304 C 0042		
Batch: 2022 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: 15** Marks **TEE: 35** Marks		**Examination Duration:** 6 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 organic compounds **CO3**: Learn organic chemistry through experiments **CO4:** Preparation of methyl orange **CO5:** Extraction of caffeine from tea leaves **CO6:** Analysis of Carbohydrate						

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	1. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc. 2. Identification of functional groups of simple organic compounds by IR spectroscopy and NMR spectroscopy (IR and NMR of simple organic compounds may be done wherever facilities are available, otherwise sample spectra may be provided for simple organic compounds like Ethanol, Aniline, Phenol, acetic acid, other simple aldehydes, carboxylic acid, etc., for identification of functional groups. References from standard spectroscopy books may also be taken for such purpose for enhancing students understanding and skill). 3. Preparation of methyl orange. 4. Extraction of caffeine from tea leaves. 5. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars using simple lab procedures.	60

Suggested Readings:

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

Course No:	Course Name: Molecular Spectroscopy & Photochemistry				Course Code: SBS CH 020305 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			3	1	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** Knowledge of radiation and its interaction with matter. Knowledge of rotation, vibration in molecules.					
Course Objectives	*To provide students with basic understanding of* various spectroscopic techniques such as rotational spectroscopy, FTIR spectroscopy, Raman spectroscopy and electronic spectroscopy. The students will be also equipped with understanding of photophysical and photochemical processes.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of basic principles of spectroscopy **CO2:** Understanding of concept of rotational spectroscopy **CO3:** Knowledge of vibrational spectroscopy, both FTIR and Raman **CO4:** Understanding principles of electronic spectroscopy **CO5:** Understanding the concept of photophysical phenomena **CO5:** Understanding of photochemistry						

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 AND ROTATIONAL 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.	15
II	**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.	15
III	**RAMAN AND ELECTRONIC SPECTROSCOPY** 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. Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.	15

IV	**PHOTOPHYSICAL AND PHOTOCHEMICAL PROCESSES** Laws of photochemistry, quantum yield. Jablonski diagrams: Franck-Condon principle, Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. Kinetics of photochemical reactions ($H_2 + Br_2 = HBr$, $2HI = H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).	15

Suggested Readings:

1. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition, International (1999).
2. Levine I. N., *Physical Chemistry*, Fourth Edition), McGraw-Hill, International (1995).
3. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach*, University Science Books (1998).
4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age, revised second edition (2017).
5. Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi, (2006).

Course No:	Course Name: Spectroscopy Practical				Course Code: SBS CH 020306 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** III	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			0	0	4	2	**Total Hrs.: 60**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 6 Hrs.					
		Pre-requisite of course: Knowledge of indicators, colorimetry, Lambert-Beers law					
Course Objectives	*To skill students about determination of indicator constant of various indicators by colorimetry and verify Beer's law for determining concentration of a given solution by colorimetry.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Practical understanding of Colorimetry **CO2:** Knowledge of indicator constant **CO3:** Practical understanding of Beer's law **CO4:** Understanding of the determination of concentration of solutions **CO5:** Develop skill of using a Colorimeter **CO6:** Understanding of adsorption						

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	**COLORIMETRY** Determination of indicator constant - colorimetry.	30
II	**VERIFICATION OF BEER'S LAW** Verification of Beer's Law - Determination of concentration of solution by colorimetry. (Instructor may explain the principle of using colorimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (*e.g.*Ni, Cu using appropriate reagent) from standard calibration curve.	30

Suggested Readings:

1. Practicals in physical chemistry – a modern approach, P.S.Sindhu, Macmillan (2009).
2. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier (1968).

Semester IV

Course No:	Course Name: Physical Chemistry-III				Course Code: SBS CH 020401 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 3	**T** 1	**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:** Concept of phases, components and degrees of freedom, Order and molecularity of a reaction, Types of catalyst, specificity and selectivity, Physical adsorption, chemisorption.					
Course Objectives	*Concept of phases, components and degrees of freedom, Order and molecularity of a reaction, Types of catalyst, specificity and selectivity, Physical adsorption, chemisorption.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Phases, components, Gibbs phase rule, Phase diagrams and applications. **CO2:** Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation. **CO3:** Catalyst – mechanism, acid base catalysis, enzyme catalysis. **CO4:** Adsorption isotherms. **CO5:** Understanding phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram. **CO6:** Understanding the basics of chemical kinetics.						

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	**PHASE EQUILIBRIA** 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, 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. *Binary solutions:* Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.	15

II	**CHEMICAL KINETICS** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudounimolecular reactions, determination of the order, kinetics of complex reactions (limited to first order): (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, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.	15
III	**CATALYSIS** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	15
IV	**SURFACE CHEMISTRY** Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, Derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.	15

Suggested Readings:

1. Atkins P. W. and De Paula J., *Physical Chemistry, (*tenth edition) 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, 2004.
4. Engel, T. & Reid, P. *Physical Chemistry* Third Edition*,* Prentice-Hall,2012.
5. Zundhal, S.S. Chemistry concepts and applications Cengage India, 2011
6. Ball, D. W. Physical Chemistry Cengage India, 2012.
7. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP, 2009.
8. Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill, 2011.
9. Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill, 2009.

Course No:	Course Name: Physical Chemistry-III Practical				Course Code: SBS CH 020402 C 0042		
Batch: 2022 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: 15** Marks **TEE: 35** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Determination of cell constant, Potentiometric titrations Determination of cell constant, Potentiometric titrations					
Course Objectives	*Determination of cell constant, Potentiometric titrations*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Determination of cell constant **CO2:** Equivalent conductance, degree of dissociation and dissociation constant of a weak acid. **CO3:** Potentiometric titrations **CO4**: Conductometric titrations of Strong acid Vs. strong base **CO5:** Conductometric titrations of Strong acid vs. weak base. **CO6:** Potassium dichromate vs. Mohr's salt						

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	**Conductometry** 1 Determination of cell constant 2 Equivalent conductance, degree of dissociation and dissociation constant of a weak acid. 3.Conductometric titrations of: Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv)weak acid vs. strong base, Strong acid vs. weak base.	30
II	**Potentiometry** Potentiometric titrations of: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base (iii) Dibasic acid vs. strong base (iv) Potassium dichromate vs. Mohr's salt.	30

Suggested Readings:

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

(List of experiments and references are suggestive. However, more experiments can be added/list of experiments can be revised as per available facilities).

Course No:	**Course Name:** Inorganic Chemistry-II				**Course Code:** SBS CH 020403 C 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			3	1	0	4	**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	**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.	15

	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.	
III	**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
IV	**INORGANIC POLYMERS** Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.	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. Atkins, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

Course No:	Course Name: Inorganic Chemistry Practical-II				Course Code: SBS CH 020404 C 0042		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
			0	0	4	2	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 6 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 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: Introduction to Quantum Chemistry				Course Code: SBS CH 020405 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** IV	**L** 3	**T** 1	**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:** Introduction to black-body radiation and distribution of energy, Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, discussion of solution of wave functions, Average and most probable distances of electron from nucleus.					
Course Objectives	*Introduction to black-body radiation and distribution of energy, Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, discussion of solution of wave functions, Average and most probable distances of electron from nucleus.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Introduction to black-body radiation and distribution of energy **CO2:** Quantitative treatment of simple harmonic osciallator model **CO3:** Qualitative treatment of hydrogen atom and hydrogen-like ions **CO4:** Scope of Physical Chemistry **CO5:** Representations of hydrogenic orbitals **CO6:** Valence bond and molecular orbital approaches						

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	**UNIT-I** Introduction to black-body radiation and distribution of energy, photo-electic effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), The uncertainty principle, The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, eigen function and values, Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals.	20
II	**UNIT-II** Quantitative treatment of simple harmonic osciallator model, setting up of Schodinger equation and discussion of solution of wave functions. Rigid rotator model and discussion of application of	20

	Schrodinger equation. idea about transformation to spherical polar coordinate, discussion on solution,	
III	**UNIT-III** Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Valence bond and molecular orbital approaches, LCAO-MO treatment of H2, H2+; bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations.	20

Suggested Readings:

1. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999
2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.
4. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
5. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).

Course No:	Course Name: Quantum Chemistry Practical				Course Code: SBS CH 020406 C 0042		
Batch: 2022 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: 15** Marks **TEE: 35** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** calculate the energy of various conformations of molecules, students gain hand-on experience in using open-source softwares, academic visit to computational labs to gain knowledge.					
Course Objectives	*Calculate the energy of various conformations of molecules, students gain hand-on experience in using open-source softwares, academic visit to computational labs to gain knowledge.*						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Building a molecular model CO2: Instructor can demonstrate the students use of hyperchem software, Gaussian software – geometry optimization). CO3: Basic idea is to encourage the students to get knowledge without keeping any rigid practical syllabus framework).						

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	**UNIT-I** (i) The students may be demonstrated hyperchem lab activities – building a molecular model (leveling of atoms, editing individual atoms, changing bond order, centrering, rotation of atoms), Selection of calculation method (*e.g.*force field calculation, ab-initio set up), displaying calculated properties, (instructor may demonstrate Computer programs that calculate the energy of various conformations of molecules and predict the lowest energy, to learn how to construct or draw representations of molecules using a molecular modeling program called HyperChem (HyperCube, Inc.), to perform geometry optimizations (energy minimizations) to determine the lowest energy conformations of molecules). (Depending upon the availability of infrastructure facilities, instructor can demonstrate the students use of hyperchem software, Gaussian software – geometry optimization). They can be allowed for academic visit to computational labs to gain knowledge and a report may be considered for viva voce/examination). Open source softwares may be used for lab demonstration and students may prepare a report along with viva-voce shall constitute practical examination. Instructor may encourage the students to gain hand-on experience in using open-source softwares	30

	(for perfoming various calculation as mentioned) in lab computers, periodic evaluation of which can also be accepted as conducting lab practical examination. Basic idea is to encourage the students to get knowledge without keeping any rigid practical syllabus framework). (Examples of the computational work that can be done: Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane σ bonds and ethene, ethyne, benzene and pyridine π bonds.	
II	**UNIT-II** ii. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of *cis* and *trans* 2-butene. iii. Visualize the electron density and electrostatic potential maps for LiH, HF, N_2, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules. (Software: ChemSketch, ArgusLab (www.planaria-software.com), TINKER 6.2 (dasher.wustl.edu/ffe), WebLab Viewer, Hyperchem, or any similar software.	30

Suggested Readings:

1.Essentials of computational chemistry – Theories and models, C. J. Crammer, Wiley, 2nd Edn.,

2.Principle and applications of quantum chemistry, V.K.Gupta, Elsevier, 2016.

3. Practicals in physical chemistry – a modern approach, P.S.Sindhu, Macmillan,

4. Experiments in Physical Chemistry, J.M.Wilson, R.J.Newcomb, A.R.Denaro, 2nd Edn., Elsevier.

5. A.R. Leach, *Molecular Modelling Principles and Application*, Longman, 2001.

6. J.M. Haile, *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons, 1997.

7. Gupta, S.P. *QSAR and Molecular Modeling*, Springer - Anamaya Publishers, 2008.

Semester V

Course No:	Course Name: Inorganic Chemistry-III				Course Code: SBS CH 020501 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** V	**L** 3	**T** 1	**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:** Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate. **CO2:** Transition metals, its stability, color, oxidation states and complexes. **CO3:** Lanthanides, Actinides – separation, color, spectra and magnetic behavior **CO4:** Bioinorganic chemistry – metal ions in biological system, its toxicity; hemoglobin. **CO5:** Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects. **CO6:** Understanding the transition metals stability in reactions, origin of colour and magnetic properties.						

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	**COORDINATION CHEMISTRY** Werner's theory, EAN rule, piano-stool compounds, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting, weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of first and second row transition metal series, Qualitative aspect of Ligand field theory, MO diagrams of representative coronation complexes, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination	15

	number 4 and 6, Chelate effect.	
II	**TRANSITION ELEMENTS** 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)	15
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: Inorganic Chemistry Practical-III				Course Code: SBS CH 020502 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** V	**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:** Qualitative semimicro analysis of mixtures, Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions.					
Course Objectives	*Qualitative semimicro analysis of mixtures, Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. **CO2:** Controlled synthesis of two copper oxalate hydrate complexes **CO3:** Preparation of acetylacetanato complexes **CO4:** Synthesis of ammine complexes **CO5:** Analysis of copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc radicals **CO6:** Exchange reactions						

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	1. Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on understanding of the chemistry of different reactions. Following radicals may be analyzed: Carbonate, nitrate, nitrite, sulphide, sulphate, sulphite, acetate, fluoride, chloride, bromide, iodide, borate, oxalate, phosphate, ammonium, potassium, lead, copper, cadmium, bismuth, tin, iron, aluminum, chromium, zinc, manganese, cobalt, nickel, barium strontium, calcium, magnesium. Mixtures containing one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot analysis/tests should be done whenever possible. 2. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors. 3. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. (Also find the λmax of the prepared complex using instrument). 4. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands	15

	like acetylacetone, DMG, glycine) by substitution method.	

Suggested Readings:

1. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.

2. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

Course No:	Course Name: Analytical Chemistry				Course Code: SBS CH 020503 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V	**L** 3	**T** 1	**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:** Fundamentals of analytical chemistry, Basics of spectroscopic, basics of separation techniques and its applications.					
Course Objectives	*Fundamentals of analytical chemistry, Basics of spectroscopic, basics of separation techniques and its applications*.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Familiarization with fundamentals of analytical chemistry. **CO2:** Basics of spectroscopic, thermal, electrochemical techniques **CO3:** Learning basics of separation techniques and its applications. **CO4:** Understanding analytical tools, statistical methods applied to analytical chemistry. **CO5:** Understanding principle of UV-Vis spectroscopy and its applications. **CO6:** Understanding principles of thermo-gravimetric analysis and study of thermal decomposition of materials/characterization of materials.						

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	**QUALITATIVE AND QUANTITATIVE ASPECTS OF ANALYSIS** Tools in analytical chemistry and their applications, Sampling, evaluation of analytical data, errors, accuracy and precision, statistical test of data; F, Q and t-test, rejection of data, and confidence intervals.	15
II	**SPECTROSCOPY** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. **Vibration spectroscopy**: Basic principles of instrumentation, sampling techniques. Application of IR spectroscopy for characterization through interpretation of data, Effect and importance of isotope substitution. Introduction to Raman spectra **UV-Visible Spectrometry:** Basic principles of instrumentation, principles of quantitative analysis using estimation of metal ions from aqueous solution, Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.	15

III	**THERMAL ANALYSIS and SEPARATION TECHNIQUES** Theory of thermogravimetry (TG and DTG), instrumentation, estimation of Ca and Mg from their mixture. Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography techniques: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis using LC, GLC, TLC and HPLC.	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. determination of pKa values.	15

Suggested Readings:

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

2 Willard, H.H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing California, USA, 1988.

3.Christian, G.D, Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.

4 Harris, D.C.: Exploring Chemical Analysis, 9th Ed. New York, W.H. Freeman, 2016.

5 Skoog, D.A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Saunder College Publications, (1998).

6 Mikes, O. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood
John Wiley 1979.

7 Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.

8 Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition)1998

9.Skoog D.A., Holler F.J., Nieman T.A., Principles of instrumental analysis, 5th Edn., Brooks & Cole (1997).

Course No:	Course Name: Analytical Chemistry Practical				Course Code: SBS CH 020504 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** V	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **15** Marks **TEE:** **35** Marks	**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Paper chromatographic separation, Determine the pH of the given aerated drinks fruit juices, shampoos and soaps, Estimation of calcium, magnesium, phosphate, nitrate, Determination of Biological oxygen demand (BOD) and chemical oxygen demand (COD).						
Course Objectives	*Paper chromatographic separation, Determine the pH of the given aerated drinks fruit juices, shampoos and soaps, Estimation of calcium, magnesium, phosphate, nitrate, Determination of Biological oxygen demand (BOD) and chemical oxygen demand (COD).*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Chromatography **CO2:** Solvent Extractions **CO3:** Analysis of soil **CO4:** Ion exchange **CO5:** Spectrophotometry **CO6:** Separation of amino acids from organic acids by ion exchange chromatography.						

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	**CHROMATOGRAPHY** (i) Paper chromatographic separation of Fe^{3+}, Al^{3+} and Cr^{3+} (ii) Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the Rf values. (iii.) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their Rf values. (iv) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC	15
II	**SOLVENT EXTRACTIONS** (i) To separate a mixture of Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}-DMG complex in chloroform, and determine its concentration by spectrophotometry.	15

	ii. Determine the pH of the given aerated drinks fruit juices, shampoos and soaps. iii. Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.	
III	**ANALYSIS OF SOIL** (i) Determination of pH of soil. (ii) Total soluble salt (iii) Estimation of calcium, magnesium, phosphate, nitrate	15
IV	**ION EXCHANGE and SPECTROPHOTOMETRY** (i) Determination of exchange capacity of cation exchange resins and anion exchange resins. (ii) Separation of metal ions from their binary mixture. (iii) Separation of amino acids from organic acids by ion exchange chromatography. (i). Determination of pKa values of indicator using spectrophotometry. (ii) Structural characterization of compounds by infrared spectroscopy. (iii) Determination of dissolved oxygen in water. (iv) Determination of chemical oxygen demand (COD). (v) Determination of Biological oxygen demand (BOD). (vi) Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.	15

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
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. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* Van Nostrand, New York, 1974.

Semester VI

Course No:	Course Name: Green Chemistry				Course Code: SBS CH 020601 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** VI	**L** 3	**T** 1	**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 introduction and explaining goals of Green Chemistry, twelve principles of Green Chemistry, Designing of Environmentally safe marine antifoulant, Combinatorial green.					
Course Objectives	*Basic introduction and explaining goals of Green Chemistry, twelve principles of Green Chemistry, Designing of Environmentally safe marine antifoulant, Combinatorial green.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Green chemistry and its principles. **CO2:** Green synthesis and reactions. **CO3:** Green chemistry for sustainable solutions. **CO4:** Understanding principles of green chemistry. **CO5:** Understanding design of chemical reactions/chemical synthesis using green chemistry principles. **CO6:** Atom economy and design of chemical reactions using the principle.						

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	**INTRODUCTION TO GREEN CHEMISTRY** Basic introduction and explaining goals of Green Chemistry. Limitations/Obstacles in the pursuit of the goals of Green Chemistry	15
II	**PRINCIPLES OF GREEN CHEMISTRY AND DESIGNING A CHEMICAL SYNTHESIS (12 CLASSES OF 60 MINUTES DURATION EACH)** Twelve principles of Green Chemistry with their explanations and examples and special emphasis on Designing a Green Synthesis using these principles (Prevention of Waste/ byproducts;	15

	maximum incorporation of the materials used in the process into the final products, Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions).	
III	**GREEN SYNTHESIS / REACTIONS** 1. Green Synthesis of adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). 2. Microwave assisted reactions in water: (Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols) and reactions in organic solvents (Diels-Alder reaction and Decarboxylation reaction). 3. Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine) 4 Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. 5 Designing of Environmentally safe marine antifoulant. 6 An efficient, green synthesis of a compostable and widely applicable plastic (poly lactic acid) made from corn. 7 Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils	15
IV	**FUTURE TRENDS IN GREEN CHEMISTRY** Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.	15

Suggested Readings:

1.Ahluwalia, V.K., Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).

2. Anastas, P.T. & Warner, J.K, *Green Chemistry- Theory and Practical*, Oxford University Press (1998).

3. Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).

4. Cann, M.C.and Connely, M.E. *Real-World cases in Green Chemistry*, ACS (2000).

5. Ryan, M.A. and Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, (2002).

6. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, Second Edition, 2010.

Course No:	Course Name: Green Chemistry practical				Course Code: SBS CH 020602 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** VI	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Preparation and characterization of nanoparticles of gold using tea leaves, Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice, photoreduction of benzophenone to benzopinacol in presence of sunlight.					

Course Objectives	*Preparation and characterization of nanoparticles of gold using tea leaves, Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice, photoreduction of benzophenone to benzopinacol in presence of sunlight.*
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Preparation of biodiesel from vegetable/ waste cooking oil. **CO2:** Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead of cyanide). **CO3:** Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II) complex. **CO4:** Use of molecular model kit to stimulate the reaction **CO5:** Preparation and characterization of nanoparticles of gold using tea leaves **CO6:** Mechanochemical solvent free synthesis of azomethines

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	**PREPARATIONS AND STUDY OF REACTIONS-I** 1. Preparation and characterization of nanoparticles of gold using tea leaves. 2. Preparation of biodiesel from vegetable/ waste cooking oil. 3. Use of molecular model kit to stimulate the reaction to investigate how the atom economy illustrates Green Chemistry. 4. Reactions like addition, elimination, substitution and rearrangement may also be studied for the calculation of atom economy.	15
II	**PREPARATIONS AND STUDY OF REACTIONS-I** 1. Benzoin condensation using Thiamine Hydrochloride as a catalyst (instead of cyanide). 2. Extraction of D-limonene from orange peel using liquid CO_2 prepared form dry ice. 3. Mechanochemical solvent free synthesis of azomethines	

	4. Solvent free, microwave assisted one pot synthesis of phthalocyanine Cu(II) complex. 5. Photoreduction of benzophenone to benzopinacol in presence of sunlight.	

Suggested Readings:

1. Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).

2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).

3. Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).

4. Sharma, R.K.; Sidhwani, I.T. and Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph, International Publishing ISBN 978-93-81141-55-7 (2013).

5. Cann, M.C. and Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).

6. Cann, M. C. and Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).

7. Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, Second Edition, 2010.

8. Pavia, D. L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach,* W.B.Saunders, 1995.

Course No:	Course Name: Materials Chemistry				Course Code: SBS CH 020603 C 3104		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** VI	**L** 3	**T** 1	**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 materials synthesis and characterization, application of various materials such as zeolites.					
Course Objectives	*Crystalline solids, crystal systems, Bravais lattices, coordination number, Introduction to Zeolites, Preparation of inorganic solids, Overview of nanostructures and nano-materials, Introduction, limitations of conventional engineering materials.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Crystalline solids – parameters, symmetry. **CO2:** Silica based materials in applications. **CO3:** Technological importance of ionic liquids, preparation of materials– using sol-gel technique. **CO4:** Nano-structured materials, self-assembled structure. **CO5:** Composites and its applications **CO6:** Understanding basic parameters of crystalline solids, symmetry and crystal structures.						

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	**BASICS OF CRYSTALLINE SOLIDS** Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesive energy, Symmetry elements, operations , translational symmetries - point groups, space groups, equivalent positions, close packed structures, voids, crystal structures, Pauling rules, defects in crystals, polymorphism, twinning.	15
II	**SILICA BASED MATERIALS** Introduction to Zeolites, metallosilicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H_2 /CO_2 gas storage and catalytic applications.	15

III	**INORGANIC SOLIDS/IONIC LIQUIDS OF TECHNOLOGICAL IMPORTANCE** Preparation of inorganic solids: Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydro-thermal method, Ion-exchange and Intercalation methods. Introduction to Solid electrolytes, inorganic liquid crystals. Ionic liquids, forces responsible for ionic liquids, synthesis and application of imidazolium and phosphonium based ionic liquids. Host-guest chemistry (elementary ideas).	15
IV	**NANOMATERIALS and COMPOSITE MATERIALS** Overview of nanostructures and nano-materials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nano-architecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	15

Suggested Readings:

1.Atkins P, Overton T., Rourke J. Weller M. and Armstrong F *Shriver and Atkins. Inorganic Chemistry* Oxford University Press, Fifth Edition, 2012.

3. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley,1974.

4. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley 2003.

5. Rodger, G.E. *Inorganic and Solid-State Chemistry*, Cengage Learning, 2002.

Course No:	Course Name: Materials Chemistry Practical				Course Code: SBS CH 020604 C 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** VI	**L** 0	**T** 0	**P** 4	**Credits** 2	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE: 15** Marks **TEE: 35** Marks		**Examination Duration:** 6 Hrs. **Pre-requisite of course:** Preparations of novalac resin/resol resin, Synthesis of materials/porous materials, Analysis of XRD pattern of crystals, Preparation of silver nano material.					
Course Objectives	*Preparations of novalac resin/resol resin, Synthesis of materials/porous materials, Analysis of XRD pattern of crystals, Preparation of silver nano material.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Preparation of urea-formaldehyde resin **CO2:** Analysis of XRD pattern of crystals. **CO3:** Interpretation of FTIR, NMR and UV-Vis data of given material. **CO4:** Determination of hydration number IR spectra. **CO5:** Preparations of novalac resin/resol resin. **CO6:** Preparation of silver nano material.						

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	**PREPARATIONS OF MATERIALS** 1. Preparation of urea-formaldehyde resin 2. Preparations of novalac resin/resol resin 3. Synthesis of materials/porous materials (Sol-gel, hydrothermal, microwave). (Similarly, other materials synthesis can be designed). 4. Preparation of silver nano material. (Similarly, other nano materials of other metals synthesis can be designed).	30
II	**CHARACTERIZATION OF MATERIALS** 1. Analysis of XRD pattern of crystals. 2. Interpretation of FTIR, NMR and UV-Vis data of given material. 3. Estimation of particle size from the BET, SEM techniques. 4. Density measurement of ionic liquids 5. Determining dynamic viscosities of given ionic liquids 6. Determination of hydration number IR spectra.	30

Suggested Readings:

1.Atkins P, Overton T., Rourke J. Weller M. and Armstrong F *Shriver and Atkins. Inorganic Chemistry* Oxford University Press, Fifth Edition, 2012.

3. Adam, D.M. *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*. John Wiley,1974.

4. Poole, C.P. & Owens, F.J. *Introduction to Nanotechnology* John Wiley 2003.

5. Rodger, G.E. *Inorganic and Solid-State Chemistry*, Cengage Learning, 2002.

List of Ability Enhancement Courses

Sr. No.	Name of the course	Course Code	L	T/ P	P	Credits
1	English for Communication	SBS CH 0201 AE 3104	3	1	0	4
2	History of Indian Science	SBS CH 0202 AE 3104	3	1	0	4
3	Good Laboratory Practices	SBS CH 0203 AE 3104	3	1	0	4
4	Cheminformatics	SBS CH 0204 AE 3104	3	1	0	4
5	Research methodology	SBS CH 0205 AE 3104	3	1	0	4
6	Chemistry in Everyday life	SBS CH 0206 AE 3104	3	1	0	4

Course No:	Course Name: English for Communication				Course Code: SBS CH 0201 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 3	**T** 1	**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 general English, English grammar, English sentence framing.						
Course Objectives	*To skill students in English communication, in English writing, technical writing in English and scientific or general science presentation in English.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of language and differentiate between writing and speech **CO2:** Understanding of way of writing thesis and argumentative writing **CO3:** Understanding the difference between formal and informal writing **CO4:** Understanding the different forms of technical writing **CO5:** Understanding of avoiding the common errors **CO6:** Understanding of making a scientific presentation						

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	**COMMUNICATION** Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.	15
II	**WRITING SKILLS** Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.	15
III	**TECHNICAL WRITING** Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.	15
IV	**PRESENTATION SKILL** Scientific presentation, presentations related to general topic of science, animation, editing.	15

Suggested Readings:

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

Course No:	Course Name: History of Indian Science				Course Code: SBS CH 0202 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 3	**T** 1	**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 history of India, knowledge of important contributions from Indian scientist in various areas of science.						
Course Objectives	*To provide students a knowledge of advancement in ancient science and the progress it made after independence and path breaking research by prominent scientists*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of innovations and development in science in ancient India **CO2:** Understanding of research organizations like CSIR, DRDO, ICAR and ICMR **CO3:** Understanding about the prominent scientists who have taken Indian science to international level **CO4:** Understanding of history of plant tissue culture in India **CO5:** Understanding of the green revolution in India, first gene cloning and first genome sequencing **CO6:** Understanding of allelopathy plant research in India						

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	**SCIENCE IN ANCIENT AND MEDIEVAL INDIA** History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India, Use of copper, bronze and iron in Ancient India, The geography in literature of Ancient India. Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine, innovations in the field of agriculture-new crop introduced new techniques of irrigation.	15
II	**INDIAN SCIENCE IN BEFORE AND AFTER INDEPENDENCE** Introduction of different surveyors, botanists and doctors as early scientist in Colonial India, Indian perception and adoption for new scientific knowledge in Modern India, Establishment of premier research organizations like CSIR, DRDO and ICAR and ICMR, Establishment of Atomic Energy Commission, Launching of the space satellites, Botanical survey of India.	15
III	**PROMINENT INDIAN SCIENTISTS** Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhtatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna, Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha and Vikram Sarabhai.	15

IV	**PROMINENT RESEARCH IN PLANT SCIENCES IN REPUBLIC OF INDIA** History of plant tissue culture from India, Green revolution in India: causes, details, and outcomes. First gene cloning in plants, First genome sequencing from India. Premier Plant Research institutes and scientists in India, GM Mustard. Allelopathy Plant research in India.	15

Suggested Readings:

1. Kuppuram G (1990) History of Science and Technology in India, South Asia Books.
2. 2. Handa O. C. (2014) Reflections on the history of Indian Science and Technology, Pentagon Press.
3. 3. Basu A (2006) Chemical Science in Colonial India: The Science in Social History, K.P. Bagchi & Co.
4. 4. Habib I, (2016.)A people's history of India 20: Technology in Medieval India, 5th Edition, Tulika Books.
5. 5. A. Rahman et al (1982) Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.
6. 6. B. V. Subbarayappa & K. V. Sarma (1985), Indian Astronomy -– A Source Book, Bombay.
7. 7. Srinivasan S, Ranganathan S (2013) Minerals and Metals heritage of India, National Institute of Advanced Studies.
8. 8. Srinivasiengar C N, (1967) The History of Ancient Indian Mathematics, World Press Private Ltd. Calcutta.
9. 9. Bhardwaj H C (2000) Metallurgy in Indian Archaeology. Tara Book Agency

Course No:	Course Name: Good Laboratory Practices				Course Code: SBS CH 0203 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 3	**T** 1	**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:** Experience of working in science laboratories and performing small experiments, knowledge of laboratory equipment and accessories.						
Course Objectives	*To skill students in laboratory practices, instrument usage, safety practice like handling acids with care*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of common calculations **CO2:** Understanding of preparation of solutions of different normality and molarity **CO3:** Understanding the use of different instruments **CO4:** Understanding of preparation of crystals, dyes **CO5:** Understanding of safety precautions while in laboratory **CO6:** Understanding of importance of cleanliness in laboratory						

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 LABORATORY PRACTICES** Common calculations in chemistry laboratories. Understanding the details on the label of reagent bottles. Preparation of solutions. Molarity and normality of common acids and bases. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.	15
II	**INSTRUMENT-TECHNIQUES AND LABORATORY PREPARATION PROCEDURE** Use of micropipette, analytical balances, pH meter, conductivity meter, rotary evaporator, potentiometer. Use of purified water in lab experiments, Cleaning and drying of glasswares, Perpartion of crystals from given salt. Preparation of Dyes, Demonstraton of preparation of material using Sol-gel procedure.	15
III	**GENERAL SAFETY PRACTICES** Precautious use of acids, wear safety googles and shoes in laboratory, use of extinguishable chemicals with much care, wear labcoat.	15
IV	**CLEANLINESS PRACTICE IN LABORATORY** Practice to keep the laboratory clean, proper storage of chemicals	15

Suggested Readings:

1. Seiler, J.P. (2005). Good Laboratory Practices: the why and how. Springer-Verlag Berlin and Heidelberg GmbH & Co. K; 2nd ed.
2. Garner, W.Y., Barge M.S., Ussary. P.J. (1992). Good Laboratory Practice Standards: Application for field and Laboratory studies. Wiley VCH.

Course No:	Course Name: Cheminformatics				Course Code: SBS CH 0204 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 3	**T** 1	**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; Modeling. 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 (2007) An introduction to Chemoinformatics. Springer: The Netherlands.
2. Gasteiger, J. and Engel, T. (2003) Chemoinformatics: A text-book. Wiley-VCH.
3. Gupta, S. P. (2011) QSAR & Molecular Modeling. Anamaya Pub.: New Delhi.

Course No:	Course Name: Research methodology				Course Code: SBS CH 0205 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 3	**T** 1	**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 research, good practices in research, idea of journals and publications.						
Course Objectives	*To skill students about research, different types of research, data collection and publishing of research work*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of different types of research **CO2:** Understanding of research methods and methodology **CO3:** Understanding the data collection and maintaining laboratory record **CO4:** Understanding the different research areas of chemistry **CO5:** Understanding of various instruments to characterize the research **CO6:** Understanding of publication of research						

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	**BASIC CONCEPTS OF RESEARCH** Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs. qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.	15
II	**DATA COLLECTION AND DOCUMENTATION OF OBSERVATIONS** Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.	15
III	**OVERVIEW OF APPLICATION TO CHEMISTRY RELATED PROBLEMS** Key chemistry research areas, chemoinfomatics.	15
IV	**BASIC KNOWLEDGE OF PUBLICATION HOUSE, JOURNALS AND INSTRUMENTATION** Characterization of samples, Instruments used for characterization, Publish the research, Access different publication house and journals associated with it, Research articles.	15

Suggested Readings:

1. A. Fink, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.
2. M. Graziano, A.M. Anthony and M. L. Raulin, Research Methods: A Process of Inquiry, Allyn and Bacon., 2009.
3. W. M. K. Trochim, Research Methods: the concise knowledge base, Atomic Dog Publishing, 2005.
4. P. D. Leedy and J. E. Ormrod, Practical Research: Planning and Design, Prentice Hall, 2004.
5. B. L. Garg, R. Karadia, F. Agarwal and U. K. Agarwal, An introduction to Research Methodology, RBSA Publishers, 2002.
6. R. A. Day, How to Write and Publish a Scientific Paper, Cambridge University Press, 1992.
7. C. R. Kothari, Research Methodology: Methods and Techniques, New Age International, 1990.

Course No:	Course Name: Chemistry in Everyday life				Course Code: SBS CH 0206 AE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 2	**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 different chemical processes people use in their everyday life in terms food habits, physical activities etc.						
Course Objectives	*To teach students how much chemistry is an integral part of our everyday life, impact of radicals on human health, vitamin and mineral chemistry,*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of mechanism of energy production via respiratory system **CO2:** Understanding of chemistry behind hazardous diseases **CO3:** Understanding the mechanism behind the formation and working of everyday life polymeric materials **CO4:** Understanding role of vitamins and minerals in body and their working mechanism **CO5:** Understanding of radical production and their impact on health **CO6:** Understanding of superoxide, peroxide and anti-oxidants						

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	**RESPIRATION AND ENERGY PRODUCTION IN HUMAN BODY** Respiration, Respiratory enzymes, brief outline of hemoglobin and myoglobin, oxygen transport mechanism in body, co-operativity, Respiration in lower animals, hemocyanine, hemerythrine. Energy production in body, ATP; enzyme responsible for food digestion, mechanism of food digestion, active site of cytochrome c-oxidase.	15
II	**CHEMICAL ASPECTS OF SOME COMMON HEALTH HAZARDS AND CHEMISTRY OF MATERIALS** Anemia, sickle cell anemia, leukemia, blood pressure irregulation, blood sugar, arthritis, carbon monoxide poisoning in mines, cyanide poisoning, fluorosis etc. Soaps and Detergents – their action, Biofuels – production of biofuels and its utility as alternative fuel source, Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA; Examples of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers. Use of polymeric materials in daily life.	15
III	**VITAMINS AND MINERALS** Need for vitamin in body, types of vitamins, water soluble and fat soluble vitamins, Vitamin B-12, vitamin C (Cyanocobalamine), D, Vitamin K. Role of minerals in body, iodine deficiency and remedy.	15

IV	**SIGNIFICANCE OF RADICAL CHEMISTRY IN LIVING SYSTEM** Radical production in environment, superoxide and peroxide, health impact, action of radicals, cell mutation, diseases caused by free radical, cancer, radical quencher, anti-oxidants, natural anti-oxidants like vegetables, beverages like tea and coffee, fruits. Radical destroying enzymes: superoxide dismutase, catalase, peroxidase, mechanism of action.	15

Suggested Readings:

1. Kaim W, Bioinorganic Chemistry, Vol 4, Brigitte Scwederski, Wiley, 1994.
2. 2. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
3. 3. Berg J. M., Tymoczeko J. L., Stryer l. Biochemistry, W. H. Freeman, 2008.
4. 4. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S. (1994) *Bioinorganic Chemistry.* University Science Books (1994)
5. 5. Lippard S., Berg J. M. Principles of Bioinorganic Chemistry; University Science Books 1994.
6. 6. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International.

List of Skill Enhancement Courses

Sr. No.	Name of the course	Course Code	L/P	T	P	Credits
1	Personality Development	SBS CH 0201 SE 2002	2	0	0	**2**
2	Computer Applications in Chemistry	SBS CH 0202 SE 2002	2	0	0	**2**
3	Science Communication and Popularization	SBS CH 0203 SE 2002	2	0	0	**2**
4	Biofertilizer	SBS CH 0204 SE 2002	2	0	0	**2**
5	Herbal Science & Technology	SBS CH 0205 SE 2002	2	0	0	**2**
6	Fermentation Science & Technology	SBS CH 0206 SE 2002	2	0	0	**2**
7	Environment Impact Analysis	SBS CH 0207 SE 2002	2	0	0	**2**

Course No:	Course Name: Personality Development				Course Code: SBS CH 0208 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE: 15** Marks **TEE: 35** Marks	**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Mental heuristics, Mental priming, Checklists, Stress management, Cognitive biases, Leadership qualities						
Course Objectives	Basic psychology skills, productivity and time management, dealing negativity, critical thinking and human resources						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Develop understanding of the concepts and principles of basic psychological skills **CO2:** Apply techniques and methods to enhance productivity and time management **CO3:** Develop critical thinking skills **CO4:** Organize human resources with improved leadership qualities **CO5:** Improve logical fallacies **CO6:** Overall personality development						

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	**BASIC PSYCHOLOGY SKILLS** Mental Heuristics and Priming, Cialdini's six psychological principles, Charisma and charisma enhancements, facing interviews	8
II	**PRODUCTIVITY AND TIME MANAGEMENT** Eisenhower Matrix, Pomodoro Technique, Dealing with Procrastination, Journaling methods, Checklists, to-do lists and scheduling the events	8
III	**DEALING NEGATIVITY** Balance, stress management, coping with failures and depression	7
IV	**CRITICAL THINKING AND HUMAN RESOURCES** Logical fallacies, Cognitive biases, Mental Models, Critical Thinking. Evaluation and improvement; Leadership qualities.	7

Suggested Readings:

1. Bast, F., Crux of time management for students (2016). Available at: https://www.ias.ac.in/article/fulltext/reso/021/01/0071-0088
2. Cialdini, R.B., Influence: The Psychology of Persuasion, Revised Edition. Harper Collius (2001).
3. Green, C.J.,Leadership and soft skills for students: Empowered to succeed in High School, College and beyond. Dog Ear Publishing (2015).
4. Velayudhan, A. and Amudhadevi, N. V., Personality Development for College Students. LAP Lambert Academic Publishing (2012).

Course No:	Course Name: Computer Applications in Chemistry				Course Code: SBS CH 0209 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Spreadsheet, Google search, Subscription, Bibliography, MS office, Image processing					
Course Objectives	*Spreadsheet Applications, Internet Resources, Bibliography management, Other software resources*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Apply the basic operations of spreadsheet applications **CO2:** Recognize advanced resources for accessing scholarly literature from internet **CO3:** Utilize bibliography management software while typing and downloading citations **CO4:** Operate various software resources with advanced functions and its open office substitutes						

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	**SPREADSHEET APPLICATIONS** Introduction of spreadsheet (MS Excel), application, formulas and functions, performing basic statistics using spreadsheet applications, creating basic graphs using spreadsheet applications, logical (Boolean) operators.	8
II	**INTERNET RESOURCES** Advanced Google search operators and Boolean functions, Introduction to Google Scholar and accessing scholarly literature from Internet, Fake News and spotting the fake news, multimedia resources and podcasts, RSS/XML Feeds and feed subscription using a feed reader.	8
III	**BIBLIOGRAPHY MANAGEMENT** Introducing a bibliography management software (for e.g. Endnote), Styles and Templates, Changing the bibliography style as per journal format, citing while typing in the office application, downloading citations from Google Scholar.	7
IV	**OTHER SOFTWARE RESOURCES** Introduction to advanced functions of MS Word and its Open Office substitutes including tracking changes, inserting page numbers and automatic table of contents, Google Docs and Forms, MS Power point, Microphotography and scale calibration with ImageJ, digital image processing (Paint.net or GIMP).	7

Suggested Readings:

1. User manual and online user manual of respective soft wares for the most updated content

2. Published books are not recommended as versions keep on updating very frequently; therefore, it is not easy to follow.

Course No:	Course Name: Science Communication and Popularization				Course Code: SBS CH 02010 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks	**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Print science, Visual media, Internet communication, Blogs, Outreach talks, Public sensitization						
Course Objectives	Print Science Communication, Visual Media Science Communication, Internet Science Communication, Science Outreach Talks and Public Sensitization						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Identify the need and role of science communication in human development CO2: utilize visual media science communication for creating scripts and documentaries CO3: Contribute in science popularization through internet communication and public sensitization						

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	**PRINT SCIENCE COMMUNICATION** Need for Science Journalism: Science has potential for breaking news, impact on Human life, impact on technology. Role of science and technology in human development. Framing policies at national and international levels. Writing and communicating popular articles effectively, case studies of celebrated works of science communicators including Cosmos by Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley, importance for communication through regional languages.	8
II	**VISUAL MEDIA SCIENCE COMMUNICATION** Advanced Google search operators and Boolean functions, Introduction to Google Scholar and accessing scholarly literature from Internet, Fake News and spotting the fake news, multimedia resources and podcasts, RSS/XML Feeds and feed subscription using a feed reader.	8
III	**INTERNET SCIENCE COMMUNICATION** Science outreach through internet: Social media, Websites, Blogs, Youtube, Podcast etc.	7
IV	**SCIENCE OUTREACH TALKS AND PUBLIC SENSITIZATION** Tactics for providing a charismatic and effective public talk, use of metaphors, speaking in context, Science outreach for biodiversity conservation sensitization of public	7

Suggested Readings:

1. Selected works of Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley.

2. Gigante, E. Marie (2018). Introducing Science Through Images: Cases of Visual Popularization (Studies in Rhetoric/Communication), University of South Carolina Press.

Course No:	Course Name: Biofertilizers				Course Code: SBS CH 02011 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Useful microbes, Cyanobacteria, Mycorrhiza, Organic farming, Recycling, Vermicompost					
Course Objectives	Useful microbes, Cyanobacteria, Mycorrhiza, Organic farming, Recycling, Vermicompost						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Develop their understanding on the concept of bio-fertilizer CO2: Identify the different forms of biofertilizers and their uses CO3: Compose the Green manuring and organic fertilizers CO4: Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers						

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	**UNIT -1** General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier-based inoculants, Actinorrhizal symbiosis. Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.	8
II	**UNIT -2** Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.	8
III	**UNIT -3** Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.	7
IV	**UNIT -4** Organic farming – Green manuring and organic fertilizers, Recycling of bio- degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.	7

Suggested Readings:

1. Dubey, R.C. (2005). A Text book of Biotechnology S.Chand & Co, New Delhi.

2. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.

3. Kumaresan, V.(2005). Biotechnology, Saras Publications, New Delhi.

4. NIIR Board. (2012). The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.

5. Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya publishers.

6. Subba Rao N.S. (2017). Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.

7. Vayas,S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

Course No:	Course Name: Herbal Science & Technology				Course Code: SBS CH 02012 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE: 15** Marks **TEE: 35** Marks		**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Herbal medicines, Plant products, Biopesticides, Pharmacognosy, Adulteration, Secondary metabolites					
Course Objectives	Herbal medicines, Plant products, Biopesticides, Pharmacognosy, Adulteration, Secondary metabolites						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Develop their understanding on Herbal Technology CO2: Define and describe the principle of cultivation of herbal products. CO3: List the major herbs, their botanical name and chemical constituents. CO4: Evaluate the drug adulteration through the biological testing CO5: Formulate the value-added processing / storage / quality control for the better use of herbal medicine CO6: Develop the skills for cultivation of plants and their value-added processing / storage / quality control						

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	**UNIT -1** Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine); Cultivation - harvesting - processing - storage of herbs and herbal products.	8
II	**UNIT -2** Value added plant products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmeticals and biopesticides, their Botanical names, plant parts used, major chemical constituents.	8
III	**UNIT -3** Pharmacognosy - Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus*, *Withania somnifera*, *Centella asiatica, Achyranthes aspera,* Kalmegh, Giloe (Tinospora), Saravar. Herbal foods, future of pharmacognosy.	7

IV	**UNIT -4** Analytical pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds). Plant gene banks, Cultivation of Plants and their value-added processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation. of some medicinal plants (Withania somnifera, neem and tulsi),	

Suggested Readings:

1. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. (2013). Current scenario of Herbal Technology worldwide: An overview. Int J Pharm Sci Res; 4(11): 4105-17.

2. Arber, Agnes. (1999). Herbal Plants and Drugs. Mangal Deep Publications, Jaipur.

3. Varzakas, T., Zakynthinos, G, and Francis Verpoort, F. (2016). Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods 5: 88.

4. Aburjai, T. and Natsheh, F.M. (2003). Plants Used in Cosmetics. Phytotherapy Research 17 :987-1000.

5. Patri, F. and Silano, V. (2002). Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1. ISBN 978-92-871-8474-0, pp 218.

6. AYUSH (www.indianmedicine.nic.in). About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy. New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.

7. Evans, W.C. (2009): Trease and Evans PHARMACOGNOSY. 16th Edition, SAUNDERS / Elsevier.

8. Sivarajan, V.V. and India, B. (1994). Ayurvedic Drugs and Their Plant Sources. Oxford & IBH Publishing Company, 1994 - Herbs - 570 pages.

9. Miller, L. and Miller, B. (2017). Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. Motilal Banarsidass,; Fourth edition .

10. Kokate, C.K. (2003). Practical Pharmacognosy. Vallabh Prakashan, Pune.

Course No:	Course Name: Fermentation Science & Technology				Course Code: SBS CH 02013 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE: 15** Marks **TEE: 35** Marks	**Examination Duration:** 2 Hrs. **Pre-requisite of course:** Microbial culture, Fermentation, Metabolites, Fermented products, Enzyme production, Bioproduct recovery						
Course Objectives	Microbial culture, Fermentation, Metabolites, Fermented products, Enzyme production, Bioproduct recovery						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Employ the process for maintenance and preservation of microorganisms CO2: Analyze the various aspects of the fermentation technology and apply for Fermentative production CO3: Demonstrate proficiency in the experimental techniques for microbial production of enzymes: amylase and protease, bio product recover						

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	**UNIT -1** Preparation of microbial culture, Preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.	8
II	**UNIT -2** Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.	8
III	**UNIT -3** Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture. Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).	7
IV	**UNIT -4** Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.	

Suggested Readings:

1. Waites M.J. (2008). Industrial Microbiology: An Introduction, 7th Edition, Blackwell Science, London, UK.

2. Prescott S.C., Dunn C.G., Reed G. (1982). Prescott & Dunn's Industrial Microbiology, 4th Edition, AVI Pub. Co., USA.

3. Reed G. (2004). Prescott & Dunn's industrial microbiology, 4th Edition, AVI Pub. Co., USA.

4. JR Casida L.E. (2015). Industrial Microbiology, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India.

5. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001) Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.

6. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

Course No:	Course Name: Environment Impact Analysis				Course Code: SBS CH 02014 SE 2002		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I/II	**L** 2	**T** 0	**P** 0	**Credits** 2	**Contact Hrs. per Week: 02** **Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks	**Examination Duration:** 2 Hrs. Environmental management, Environmental impact assessment, Project proponent, Consultant, Environmental audit, Risk assessment, Legislation						
Course Objectives	Environmental management, Environmental impact assessment, Project proponent, Consultant, Environmental audit, Risk assessment, Legislation						
Course Outcomes:	After completing this course, student is expected to learn the following: CO1: Have critical understanding of environmental impact CO2: Learn important steps of EIA process CO3: Interpret the environmental appraisal and procedures in India.						

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	**ORIGIN AND DEVELOPMENT** Purpose and aim, core values and principles, History of EIA development, Environmental Management Plan, Environmental Impact Statement, Scope of EIA in Project planning and Implementation.	8
II	**EIA PROCESS** Components of EIA, EIA Methodology- Screening, Scoping, Baseline data, Impact Identification, Prediction, Evaluation and Mitigation, Appendices and Forms of Application, Techniques of Assessment-Cost-benefit Analysis, Matrices, Checklist, Overlays, Impact on Environmental component: air, noise, water, land, biological, social and environmental factors. EIA Document.	8
III	**MAIN PARTICIPANTS IN EIA PROCESS** Role of Project proponent, environmental consultant, PCBs, PCCs, public and IAA. Public participation.	7
IV	**ENVIRONMENTAL APPRAISAL AND PROCEDURES IN INDIA AND EIA** Methodology, indicators and mitigation, Environmental Audit of different environmental resources, Risk Analysis, Strategic environmental assessment, ecological impact assessment: legislation.	

	PRACTICAL 1. Prepare a Matrix of every environmental existing resource of your college or your hostel/mohalla or any defined area and evaluate each component using established methods and make audit analysis 2. Prepare a case report of Environmental impact of any area under development	

Suggested Readings:

1. Kulkarni V and Ramachandra TV, (2006). Environmental Management, Capital Pub. Co. New Delhi.
2. Petts, J. (2005) Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK.
3. Glasson, J. Therivel, R. and Chadwick, (2006) A. Introduction to Environmental Impact Assessment. Routledge, London.
4. Canter, W. L. (1995) Environmental Impact Assessment, McGraw-Hill Science/ Engineering/ Math, New York;
5. Morris, P. and Therivel, R. (1995) Methods of Environmental Impact Assessment, UCL Press, London;
6. Petts, J. (1999) (ed) Handbook of Environmental Impact Assessment, volume 1 and 2, Blackwell Science, Oxford;
7. Therivel, R. and Partidario, M. R. (1996) (eds) The Practice of Strategic Environmental Assessment, Earthscan, London;
8. Vanclay, F. and Bronstein, D. A. (1995) (eds) Environmental and Social Impact Assessment, Wiley & Sons, Chichester

List of Discipline Specific Elective Courses

Sr. No.	Name of the Course	Course Code	L	T	P	Credits
1	Medicinal Chemistry	SBS CH 0201 DSE 3104	3	1	0	**4**
2	Medicinal Chemistry Practical	SBS CH 0202 DSE 0042	0	0	4	**2**
3	Electrochemistry	SBS CH 0203 DSE 3104	3	1	0	**4**
4	Electrochemistry Practical	SBS CH 0204 DSE 0042	0	0	4	**2**
5	Advanced Material Chemistry	SBS CH 0205 DSE 3104	3	1	0	**4**
6	Material Chemistry Practical	SBS CH 0206 DSE 0042	0	0	4	**2**
7	Advanced Analytical Chemistry	SBS CH 0207 DSE 3104	3	1	0	**4**
8	Analytical Chemistry Practical	SBS CH 0208 DSE 0042	0	0	4	**2**
9	Organic Spectroscopy	SBS CH 0209 DSE 3104	3	1	0	**4**
10	Organic Spectroscopy Practical	SBS CH 0210 DSE 0042	0	0	4	**2**
11	Heterocyclic Chemistry	SBS CH 0211 DSE 3104	3	1	0	**4**
12	Heterocyclic Chemistry Practical	SBS CH 0212 DSE 0042	0	0	4	**2**
13	Organometallics and Bioinorganic Chemistry	SBS CH 0213 DSE 3104	3	1	0	**4**
14	Organometallics and Bioinorganic Chemistry Practical	SBS CH 0214 DSE 0042	0	0	4	**2**
15	Introduction to Nanochemistry & Applications	SBS CH 0215 DSE 3104	3	1	0	**4**
16	Nanochemistry Practical	SBS CH 0216 DSE 0042	0	0	4	**2**

Course No:	Course Name: Medicinal Chemistry				Course Code: SBS CH 0201 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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:** The basics of medicinal chemistry, biophysical properties, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of stereochemistry in terms of biological response with examples						
Course Objectives	The basics of medicinal chemistry, biophysical properties, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of stereochemistry in terms of biological response with examples						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** The basics of medicinal chemistry, biophysical properties **CO2:** Biological activity parameters **CO3:** Drug metabolism **CO4:** Biophysical and chemical properties of enzymes, hormones, vitamins **CO5:** Concept of rational drug design **CO6:** Synthesis, preparation and purification of medicinal 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	**BIO-PHYSICOCHEMICAL PROPERTIES** Acidity/Basicity, Solubility, Ionization, Hydrophobic properties, Hydrophilic properties, Lipinski Rule, Drug-like properties, Understanding of the biological activity parameters such as K_i, K_d, LD_{50}, EC_{50}, IC_{50}, CC_{50}, ADMET properties	15
II	**STRUCTURAL PROPERTIES AND DRUG TARGET UNDERSTANDING** Isosterism, Bioisosterism, Nonclassical isosteres, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of Configuration and Conformation with examples, Concept of stereochemistry in terms of biological response with examples, Stereoselective receptors or enzymes such as muscarinic receptor, Stereochemically pure drug and recemates, Examples such as catecholamines, etc. Metabolism, Drug metabolism, Anti-metabolite, Enzyme inhibitor, Agonist, Antagonist, Examples.	15
III	**MEDICINAL CHEMISTRY OF THERAPEUTIC AGENT** Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardivascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents	15

IV	**STEROIDS, PROSTAGLANDINS, ENZYME, HORMONE AND VITAMINS, RATIONAL DRUG DESIGN** Biophysico-chemical properties, Steroid Hormone Receptors, Chemical Contraceptive agents, COX-2 inhibitors, Prostaglandins for Ophthalmic use, pharmaceutically important enzyme products such as Pancreatin, Trypsin, Insulin. Classification of vitamins with examples. Structure activity relationship, Drug-receptor understanding, Molecular modeling, Structure based drug design. QSAR.	15

Suggested Readings:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical ...by Charles Owens Wilson, John H. Block, Ole Gisvold, John Marlowe Beale
2. Foye's Principles of Medicinal Chemistry by David A. Williams, Thomas L. Lemke, William O. Foye (2008), Kluwer publication.
3. Remington: The Science and Practice of Pharmacy Vol 1, Ed. 19 by Joseph Price Remington, Alfonso R. Gennaro. (1995), MACK Publishing.
4. Burgers Medicinal Chemistry by Manfred E. Wolff, Alfred Burger
5. Burgers Medicinal Chemistry and Drug Discovery by Abraham D. J., Lewis F. L., Burger A., vol.5, 6th Edn., 2003, Hoboken N.J.Wiley,
6. The Organic Chemistry of Drug Design and Drug Action by Silverman R. B., 2nd Edn., Academic Press. 2012.
7. Exploring QSAR: Fundamental and applications in Chemistry and Biology by Hansch C. and Leo, A American Chemical Society (1995)
8. Patrick, G. Medicinal Chemistry, Oxford.University Press (2000)

Course No:	Course Name: Medicinal Chemistry Practical				Course Code: SBS CH 0202 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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:** The basics of medicinal chemistry, biophysical properties, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of stereochemistry in terms of biological response with examples.					
Course Objective	*The basics of medicinal chemistry, biophysical properties, Understanding of the 3D-structure along with bond length, bond angle and dihydral angle, Concept of stereochemistry in terms of biological response with examples*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** The basics of medicinal chemistry, biophysical properties **CO2:** Biological activity parameters **CO3:** Drug metabolism **CO4:** Biophysical and chemical properties of enzymes, hormones, vitamins **CO5:** Concept of rational drug design **CO6:** Synthesis, preparation and purification of 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	**PURIFICATION AND PREPARATION** 1.Purification Techniques of Solvents by Fractional Distillation and Vacuum Distillation 2.Thin Layer Chromatography Technique and Purification of commercially available drugs/Synthesized Compounds by Column Chromatography. 3. Preparation of Acid/Basic Salts of Drugs and Evaluation of their Physicochemical Properties. (Benzilic Acid & Sodium Benzoate)	30
II	**SYNTHESIS AND COMPUTATIONAL MODELING** Synthesis & Purification of following Compounds using: (i)Precipitation or Recrystallization. (ii)Synthesis of Benzimidazole. (iii)Synthesis of Anthranilic Acid. (iv)Synthesis of Sulphanilamide. (v)Synthesis of benzoic acid from benzyl alcohol. (vi)Synthesis of 1,4 – dihydropyridine. Computational modeling of drug design/use of softwares may be demonstrated to students.	30

Suggested Readings:

1. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J. D. Barnes, M. J. K Thomas, 6th Edition, Pearson's Education Ltd.
2. Advanced Practical Medicinal Chemistry, Ashutosh Kar, New Age International Ltd. (2004).
3. Vogel‟s Textbook of Practical Organic Chemistry, B. S. Furniss, A. J. Hannaford, P.W.G. Smith, A. R Tatchell, 5th edition (2008), Pearson's Education Ltd.

Course No:	Course Name: Electrochemistry				Course Code: SBS CH 0203 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 electrochemistry, idea of electrochemical potential, knowledge of electrodes.					
Course Objectives	Basic principle of laws of electrochemistry, understanding about chemical cells and their function, understanding of potentiometric titrations and their applications.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Basic principle of laws of electrochemistry. **CO2:** Understanding about chemical cells and their function **CO3:** Understanding about electrodes, EMF measurement. **CO4:** Understanding about potentiometric titrations and their applications. **CO5:** Designing electrochemical cell. **CO6:** Use of electrochemical cell for various electrochemical 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	**Unit-I** Arrhenius 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 (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.	15
II	**Unit-II** Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to 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/Sb2O3 electrodes. Concentration cells	15

	with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	
III	**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 pKa values.	15
IV	**ELECTRICAL & MAGNETIC PROPERTIES OF ATOMS AND MOLECULES** Structure, Chemistry, Mode of action and adverse effect of the representative therapeutic agents such as Anti-infective agent, Antimalarials, Antibacterial, Antiviral, Anticancer, CNS acting drugs, Adrenergic Agents, Cholinergic Drugs, Diuretics, Cardivascular, local anesthetic agent, Analgesic Agents, Histamine and Antihistamine agents	15

Suggested Readings:

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

Course No:	Course Name: Electrochemistry Practical				Course Code: SBS CH 0204 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 electrochemistry, idea of electrochemical potential, knowledge of electrodes.						
Course Objectives	Basic principle of laws of electrochemistry, understanding about chemical cells and their function, understanding of potentiometric titrations and their applications.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Basic principle of laws of electrochemistry. **CO2:** Understanding about chemical cells and their function **CO3:** Understanding about electrodes, EMF measurement. **CO4:** Understanding about potentiometric titrations and their applications. **CO5:** Designing electrochemical cell. **CO6:** Use of electrochemical cell for various electrochemical 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	**DETERMINATION OF pH AND CELL CONSTANT** 1.Determination of pH of a given solution using glass electrode. 2. Determination of cell constant. 3. Determination of equivalent conductance, degree of dissociation, and dissociation constant of weak acid.	30
II	**CONDUCTOMETRIC AND POTENTIOMETRIC TITRATION** 1. Conductometric titration: strong acid *vs*. strong base, weak acid *vs*. strong base. 2. Potentiometric titration: strong acid *vs*. strong base, weak acid *vs*. strong base, potassium dichromate vs. mohr's salt.	30

Suggested Readings:

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

Course No:	Course Name: Advanced Materials Chemistry				Course Code: SBS CH 0205 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 single crystals and X-ray diffraction, synthesis of nanomaterials and their characterization, knowledge of different microscopies.					
Course Objectives	Introduction of Growth of single crystals, Crystal structure determination by X-ray diffraction, d-spacing formula, Synthesis of nanowires and nanotubes by CVD and MOCVD method, Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy, Biodegradable polymers.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Advanced idea of X-ray diffraction **CO2:** Structure solution by X-ray diffraction **CO3:** Synthesis and characterization of nanomaterials **CO4:** Use of nanomaterials in magnetism **CO5:** Knowledge of various types of polymers **CO6:** Idea of biodegradable 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	**CRYSTAL STRUCTURE OF SOLIDS** Fundamental of lattices, unit cell, atomic coordinates, Bravais lattices, crystal direction and planes, types of close packing, packing efficiency, radius ratios; few important crystal structures. Synthesis of Inorganic solids; solid state, solution phase and vapor phase synthesis; precipitation, hydrothermal, sol-gel, surfactant-based synthesis. Growth of single crystals. Crystal structure determination by X-ray diffraction, d-spacing formula, symmetrically absent reflections, Multiplicities, Scattering of X-rays by an atom and a crystal. Single crystal and powder diffraction. Electron and neutron diffraction. Concept of reciprocal lattice. Electron microscopy techniques.	15
II	**NANOMATERIAL FUNDAMENTALS** Synthesis: Bottom-up vs. Top-down Methods. Solution phase synthetic methods. Role of surfactant in shape and size control of nanomaterials. Synthesis of nanowires and nanotubes by CVD and MOCVD method. Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy. Nanomaterial properties and applications: Magnetic properties of nanoparticles;	15

	superparamagnetism, ferromagnetism in antiferromagnetic nanoparticles and single domain to multidomain transition. magnetic nanoparticles as MRI contrast agents.	
III	**POLYMER SCIENCE AND TECHNOLOGY** Conducting polymers: basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers. Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.	15
IV	**BIODEGRADABLE POLYMERS** Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soy protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, poly(vinyl alcohol), polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells. Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.	15

Suggested Readings:

1. Zhen Guo and Li Tan, Fundamentals and Applications of Nanomaterials.2009, Artech House, London Publication.
2. Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
3. Polymer science, V. R. Gowariker, N. V.Viswanathan, J. Sreedhar, New Age International (P) Ltd., 2015.
4. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
5. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
6. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int.Publication, 2019.

Course No:	Course Name: Materials Chemistry Practical				Course Code: SBS CH 0206 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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**: Idea of single crystals and X-ray diffraction, synthesis of nanomaterials and their characterization, knowledge of different microscopies.						
Course Objectives	Introduction of Growth of single crystals, Crystal structure determination by X-ray diffraction, d-spacing formula, Synthesis of nanowires and nanotubes by CVD and MOCVD method, Nanomaterials Characterization: XRD of nanomaterials, Electron microscopy (SEM, TEM, HRTEM and EDX) of nanomaterials, Scanning probe microscopy, Biodegradable polymers.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Advanced idea of X-ray diffraction **CO2:** Structure solution by X-ray diffraction **CO3:** Synthesis and characterization of nanomaterials **CO4:** Use of nanomaterials in magnetism **CO5:** Knowledge of various types of polymers **CO6:** Idea of biodegradable polymers						

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	**PREPARATION OF NANOMATERIALS AND POLYMERS** 1. Preparation of gold and silver nano-particles. 2. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein	30
II	**X-RAY DIFFRACTION AND CHARACTERIZATION OF NANOMATERIALS** 1. Analysis of XRD pattern of few selected crystals like $NaNO_3$, $CaCl_2$, etc.; Indexing of a given powder diffraction pattern of a cubic crystalline system. 2. Interpretation of FTIR, NMR and UV-Vis data of given material. 3. Estimation of particle size from the BET, SEM techniques.	30

Suggested Readings:

1. Fahlman, B.D. Materials Chemistry, Springer, 2004.
2. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
3. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
4. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int.Publication, 2019.

Course No:	Course Name: Advanced Analytical Chemistry				Course Code: SBS CH 0207 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 chemistry, idea of errors and deviation, knowledge of characterization of materials.						
Course Objectives	Introduction of Theory of error and treatment of quantitative data, accuracy and precision, qualitative and quantitative applications, instruments and applications of theromogravimetric analysis, Principles of chromatography.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Statistical methods in chemical analysis **CO2:** Polarography **CO3:** Atomic spectroscopy **CO4:** Thermal analysis **CO5:** Chromatography **CO6:** Analysis of fuel and drugs						

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	**STATISTICAL METHODS IN CHEMICAL ANALYSIS** Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).	15
II	**POLAROGRAPHY AND ATOMIC SPECTROSCOPY** Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications. Atomic absorption spectroscopy, theory and application (with some examples).	15
III	**THERMAL ANALYSIS AND CHROMATOGRAPHY** Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA), and differential scanning calorimetry (DSC). Principles of chromatography, paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.	15

IV	**ANALYSIS OF FUEL AND DRUGS** **Fuel analysis:** Solid, liquid and gaseous fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point. **Drug analysis:** Classification of drugs, Analysis of some standard drug using various chromatographic techniques.	15

Suggested Readings:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth Publishing California, USA, 1988.
3. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*
6. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood
7. John Wiley 1979.
8. Ditts, R.V. Analytical Chemistry; Methods of separation, van Nostrand, 1974.
9. Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998

Course No:	Course Name: Analytical Chemistry Practical				Course Code: SBS CH 0208 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 analytical chemistry, idea of errors and deviation, knowledge of characterization of materials.						
Course Objectives	Introduction of Theory of error and treatment of quantitative data, accuracy and precision, qualitative and quantitative applications, instruments and applications of theromogravimetric analysis, Principles of chromatography.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Statistical methods in chemical analysis **CO2:** Polarography **CO3:** Atomic spectroscopy **CO4:** Thermal analysis **CO5:** Chromatography **CO6:** Analysis of fuel and drugs						

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	**CHROMATOGRAPHY** 1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. Preparation of buffer solutions of different pH (i. Sodium acetate-acetic acid, ii. Ammonium chloride-ammonium hydroxide 2. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III) 3.Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.	30
II	**CHARACTRIZATIONS** 1. IR/DSC analysis of known polymer sample (for students' demonstration only) 2. Determination of viscosity index, cloud point, pour point of given fuel sample. 3. Determination of calorific value of given fuel sample/coal sample using bomb calorimeter. 4. Determination of the iodine number of oil. 5. Determination of the saponification number of oil.	30

Suggested Readings:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Jain, P.C. & Jain, M. Engineering Chemistry Dhanpat Rai & Sons, Delhi.
3. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009
4. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.

Course No:	Course Name: Organic Spectroscopy				Course Code: SBS CH 0209 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 radiation and its interaction with matter, idea of electronic levels in atoms and molecules, theory of molecular spectroscopy.						
Course Objectives	*Application of visible, ultraviolet and infrared spectroscopy in organic molecules, Identification of Functional groups of various classes of organic compounds, Application of Chemical Shifts, Application of fragmentation rule in characterization of organic compounds.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Basic Principles of UV Spectroscopy **CO2:** Basic principles of IR Spectroscopy **CO3:** NMR (^{1}H and ^{13}C NMR) **CO4:** Basic principles Mass Spectrometry **CO5:** Use of spectroscopy in characterizing molecules **CO6:** Study of unknown 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	**BASIC PRINCIPLES OF UV SPECTROSCOPY** Application of Woodward-Fiser rule in interpretation of Organic compounds: Application of visible, ultraviolet and infrared spectroscopy in organic molecules. Electromagnetic radiation, electronic transitions, λmax & εmax, chromophore, auxochrome, bathochromic and hypsochromic shifts. Application of electronic spectroscopy and Woodward rules for calculating λmax of conjugated dienes and α,β – unsaturated compounds.	15
II	**BASIC PRINCIPLES OF IR SPECTROSCOPY** Identification of Functional groups of various classes of organic compounds: 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).	15
III	**NMR (^{1}H AND ^{13}C NMR)** Application of Chemical Shifts, Splitting of signals, Spin coupling and Over Houser effect in interpretation of NMR spectra, Isotopic exchange	15

IV	**BASIC PRINCIPLES MASS SPECTROMETRY** Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data.	15

Suggested Readings:

1. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
2. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

Course No:	Course Name: Organic Spectroscopy Practical				Course Code: SBS CH 0210 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 radiation and its interaction with matter, idea of electronic levels in atoms and molecules, theory of molecular spectroscopy.						
Course Objectives	*Application of visible, ultraviolet and infrared spectroscopy in organic molecules, Identification of Functional groups of various classes of organic compounds, Application of Chemical Shifts, Application of fragmentation rule in characterization of organic compounds.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Basic Principles of UV Spectroscopy **CO2:** Basic principles of IR Spectroscopy **CO3:** NMR (^{1}H and ^{13}C NMR) **CO4:** Basic principles Mass Spectrometry **CO5:** Use of spectroscopy in characterizing molecules **CO6:** Study of unknown 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	**PURIFICATION OF COMPOUNDS** Purification method for liquid, solid organic substance (distillation, recrystallization, chromatorgrapy).	30
II	**CHARACTRIZATIONS** Analysis of spectra of UV-Vis, FTIR, NMR and Mass of simple organic compounds. Students need to identify/analyze important peaks/functionality, determine mass of the molecules (mass-spectra). They can submit a report regarding their analysis to course teacher.	30

Suggested Readings:

3. R.M. Silverstein, G.C. Bassler & T.C. Morrill: Spectroscopic Identification of Organic Compounds, John Wiley & Sons.
4. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

Course No:	Course Name: Heterocyclic chemistry				Course Code: SBS CH 0211 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 basic organic chemistry, synthesis and various reactions, knowledge of hetero atoms in compounds.						
Course Objectives	*Synthetic approaches and reactivities, natural products: synthesis of Penicillin and cephalosporine, general synthetic approaches.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Three-membered rings **CO2:** Three-membered heterocycles with two heteroatoms **CO3:** Four-membered heterocycles **CO4:** Five-membered aromatic heterocycles **CO5:** Synthesis of heterocycles **CO6:** Knowledge of benzofurans and indoles						

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	**HETEROCYCLIC CHEMISTRY** Three-membered rings with one heteroatom: Chemistry of oxiranes, aziridines and episulphides - synthetic approaches and reactivities. Three-membered heterocycles with two heteroatoms: oxaziranes, diaziridines and diazirines - synthetic approaches and reactivities.	15
II	**FOUR-MEMBERED HETEROCYCLES** oxitanes, azatidanes and thietanes - synthetic approaches and reactivities. natural products:synthesis of Peniciline and cephalosporine.	15
III	**FIVE-MEMBERED AROMATIC HETEROCYCLES** Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data.	15
IV	**CONDENSED FIVE-MEMBERED HETEROCYCLES** Benzofuran, indoles and benzothiazoles - general synthetic approaches, with greater emphasis on the chemistry of Indoles.	15

Suggested Readings:

1. Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.
2. The Essence of heterocyclic Chemistry, A. R. Parikh, H. Parikh, R. Khunt, New Age Int. Publication,
3. Principles of Modern Heterocyclic Chemistry, L. A. Paquette, W. A. Benjamin, New York, 1968.
4. Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London, 1978.
5. Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees), Vol 1-8, Pergamon Press, 1984.
6. Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.
7. Van der plas, H. C. Ring transformations of Heterocycles, Vols 1 and 2, Academic Press, 1974.

Course No:	Course Name: Heterocyclic Chemistry Practical				Course Code: SBS CH 0212 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 basic organic chemistry, synthesis and various reactions, knowledge of hetero atoms in compounds.						
Course Objectives	*Synthetic approaches and reactivities, natural products: synthesis of Penicillin and cephalosporine, general synthetic approaches.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Three-membered rings **CO2:** Three-membered heterocycles with two heteroatoms **CO3:** Four-membered heterocycles **CO4:** Five-membered aromatic heterocycles **CO5:** Synthesis of heterocycles **CO6:** Knowledge of benzofurans and indoles						

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	**IDENTIFICATION** 1. Identification of hetero atoms (S, N, X) in given organic compounds in lab. 2. Identification/separation of simple organic compounds containing hetero atoms using column chromatorgapy/TLC) in lab.	30
II	**SPECTROSCOPIC INDENTIFICATION AND PREPARATION** 1. Spectroscopic identification of simple organic compounds (spectra may be provided to the students and teachers may help the students to identify the compounds using spectra). Melting point/boiling point of the compounds may be checked for its purity. 2. Preparation of Indigo (using aldol condensation reaction of 2-nitrobenzaldehyde with acetone in basic condition).	30

Suggested Readings:

1. Heterocyclic Chemistry, J.A. Joule, K. Mills, Wiley, 2010.
2. Heterocyclic Chemistry, J.A. Joule and G. F. Smith, van Nostrand, London, 1978.
3. Comprehensive Heterocyclic Chemistry. The structure, reactions, synthesis and use of Heterocyclic compounds, (Ed. A.R. Katritzky and C. W. Rees), Vol 1-8, Pergamon Press, 1984.
4. Handbook of Heterocyclic Chemistry, A. R. Katritzky, Pergamon Press, 1985.

Course No:	Course Name: Organometallics and Bioinorganic Chemistry				Course Code: SBS CH 0213 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 metal-carbon bonds and fundamentals of organometallic chemistry, idea of metals in biology, knowledge of proteins and enzymes.					
Course Objectives	*Oxidation states displayed by Cr, Fe, Co, Ni and Co, General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series, stabilization of protein structures and structural role (bones).*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Chemistry of 3d metals **CO2:** Organometallic Compounds **CO3:** Bioinorganic chemistry **CO4:** Knowledge of various enzymes and proteins in biological systems **CO5:** Ion-transport **CO6:** Use of organometallic compounds in catalysis						

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 3D METALS** Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties); Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.	15
II	**ORGANOMETALLIC COMPOUNDS-I** Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.	15
III	**ORGANOMETALLIC COMPOUNDS-II** Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.	15

	Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. 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). Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.	
IV	**BIOINORGANIC 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

Suggested Readings:

1.Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
4.Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

Course No:	Course Name: Organometallics and Bioinorganic chemistry Practical				Course Code: SBS CH 0214 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 metal-carbon bonds and fundamentals of organometallic chemistry, idea of metals in biology, knowledge of proteins and enzymes.						
Course Objectives	*Oxidation states displayed by Cr, Fe, Co, Ni and Co, General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series, stabilization of protein structures and structural role (bones).*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Chemistry of 3d metals **CO2:** Organometallic Compounds **CO3:** Bioinorganic chemistry **CO4:** Knowledge of various enzymes and proteins in biological systems **CO5:** Ion-transport **CO6:** Use of organometallic compounds in catalysis						

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	**GRIGNARD REAGENT** 1.Rection of metal with halide – preparation of Grignard reagent. (only demonstration purpose) 2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)	30
II	**PREPARATION OF COMPLEXES** 1. Preparation of various Schiff base-metal complexes and their identification using spectroscopy. 2. Preparation of any two of the following complexes and measurement of their conductivity measurement: a. tetraamminecarbonatocobalt (III) nitrate b. tetraamminecopper (II) sulphate c. potassium trioxalatoferrate (III) trihydrate	30

Suggested Readings:

1. Synthesis of organometallic compounds: A practical guide, S. Komiya, Wiley.
2. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th 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.

Course No:	Course Name: Introduction to Nanochemistry & Applications				Course Code: SBS CH 0215 DSE 3104		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** V/VI	**L** 3	**T** 1	**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 nanomaterials, its synthesis and characterizations, idea of carbon nanotubes, fullerene, graphene etc.						
Course Objectives	Introduction to nanoscience, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties, Brief introduction about Top-down and Bottom-up approaches, Electron microscopic technique.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Introduction to nanoscience **CO2:** Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles. **CO3:** Examples of preparation of gold and silver metallic nanoparticles, **CO4:** Material characterization techniques **CO5:** Advanced application of nanomaterials **CO6:** Knowledge of quantum dots						

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** Introduction to nanoscience, nanostructure and nanotechnology (basic idea), Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot); Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles.	25
II	**PROPERTIES OF NANOMATERIALS** Size dependent properties of nanomaterials (basic idea with few examples only): Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties.	20
III	**SYNTHESIS OF NANOMATERIALS** Synthesis of Nanomaterials: Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-controlof nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.	

IV	**CHARACTERIZATION OF NANOMATERIALS** Material characterization techniques (basic idea of use of following instruments in nanomaterial characterization need to be emphasized): Electron microscopic technique, diffraction technique, photoelectron spectroscopy, zeta-potential measurement; Examples of use of nanomaterials in environmental remediation and biology (few practical examples of use of materials can be discussed).	

Suggested Readings:

1.C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Willey-VCH Verlag, Germany, 2005.

2.G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, Imperial College Press, London, 2004

3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England, 2005

4.Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.

5. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

Course No:	Course Name: Nanochemistry Practical				Course Code: SBS CH 0216 DSE 0042		
Batch: 2022 onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **V/VI**	**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 nanomaterials, its synthesis and characterizations, idea of carbon nanotubes, fullerene, graphene etc.						
Course Objectives	Introduction to nanoscience, Electrical, Optical (Surface Plasmon resonance), variation in colors (Blue shift & Red shift), Magnetic, thermal and catalytic properties, Brief introduction about Top-down and Bottom-up approaches, Electron microscopic technique.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Introduction to nanoscience **CO2:** Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod, and disc shapes nanoparticles. **CO3:** Examples of preparation of gold and silver metallic nanoparticles, **CO4:** Material characterization techniques **CO5:** Advanced application of nanomaterials **CO6:** Knowledge of quantum dots						

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	**SYNTHESIS OF NANOPARTICLES** 1.Synthesis of ZnO nanoparticles. 2. Preparation of Silver nanoparticles. (diverse nanoparticles can be prepared by various routes)	30
II	**BEER-LAMBERT LAW** Verfification of Beer-Lambert law using nano-particles (above prepared nano-particles may be used for the study).	30

Suggested Readings:

1. Pradeep T., A text book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012 edition.

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 020103 GE 4004	4	0	0	**4**
4	GE Lab: Chemical Energetics, Equilibria & Functional Organic Chemistry-I	SBS CH 020104 GE 0042	0	0	4	**2**
5	Solutions, Phase Equilibria, Conductance, Electrochemistry, & Functional Group Organic Chemistry	SBS CH 020201 GE 4004	4	0	0	**4**
6	GE Lab: Solutions, Phase Equilibria, Conductance, Electrochemistry, & Functional Group Organic Chemistry	SBS CH 020202 GE 0042	0	0	4	**2**
7	GE: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics	SBS CH 020203 GE 4004	4	0	0	**4**
8	GE Lab: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics	SBS CH 020204 GE 0042	0	0	4	**2**
9	Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons & UV, IR Spectra	SBS CH 020301 GE 4004	4	0	0	**4**
10	GE Lab: Organometallics, Bio-inorganic Chemistry, Polynuclear Hydrocarbons & UV, IR Spectra	SBS CH 020302 GE 0042	0	0	4	**2**
11	GE: Quantum Chemistry, Spectroscopy & Photochemistry	SBS CH 020303 GE 4004	4	0	0	**4**
12	GE Lab: Quantum Chemistry, Spectroscopy & Photochemistry	SBS CH 020304 GE 0042	0	0	4	**2**
13	Molecules of Life	SBS CH 020401 GE 4004	4	0	0	**4**

14	GE Lab: Molecules of Life	SBS CH 020402 GE 0042	0	0	4	**2**
15	Chemistry of Main Group Elements, Theories of Acids & Bases	SBS CH 020403 GE 4004	4	0	0	**4**
16	GE Lab: Chemistry of Main Group Elements, Theories of Acids & Bases	SBS CH 020404 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: 2022 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. 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	14

	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. 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).	16
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	14

	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. $KMnO_4$	

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 International Publishers, 2010.
5. R.T. Morrison & R.N. Boyd, Organic Chemistry, Pearson, 2010.
6. 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 Reactivity, Pearson Education India, 2006.
8. E.L. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. F.A. Cotton, G. Wilkinson, & P.L. Gaus, Basic Inorganic Chemistry, 3rd Edition, Wiley, 1995.
10. J.D. Lee, Concise Inorganic Chemistry ELBS, 1991.
11. P. Sykes, A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi 1988.
12. Cotton, F.A., Wilkinson, G. & Gaus, P.L., Basic Inorganic Chemistry, 3rd Edition, Wiley, 1995.
13. 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: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** **I**	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **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). 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.	30

	(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 020103 GE 4004		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
		I	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 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.	15

	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	
	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. *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.	15

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 020104 GE 0042		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I	**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: (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.	30
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.	30

	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	

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 020201 GE 4004		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**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, 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-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**	**15**

	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. 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.	**15**
IV	**AMINO ACIDS, PEPTIDES AND PROTEINS, AND CARBOHYDRATES** **Amino Acids, Peptides and Proteins**	**15**

	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.	

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 Biochemistry 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 020202 GE 0042		
Batch: 2022 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: 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: $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$ $Cu^{2+}(aq) + xNH_2(aq) \rightleftharpoons [Cu(NH_3)_x]^{2+}$ **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. **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:	30

	(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.

Course No:	Course Name: GE: Transition Metal & Coordination Chemistry, States of Matter & Chemical Kinetics				Course Code: SBS CH 020203 GE 4004		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** II	**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.	**15**

	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.	
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 020204 GE 0042		
Batch: 2022 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:** 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 oxime 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). 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.	30

	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 020301 GE 4004		
Batch: 2022 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 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); 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-	**15**

	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. 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).	**15**

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 020302 GE 4004		
Batch: 2022 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** **III**	**L**	**T**	**P**	**Credit**	**Contact Hrs. per Week: 04**
			0	0	4	2	**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** 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.	30

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 020303 GE 4004		
Batch: 2022 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 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. 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.	**15**

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. 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.	**15**
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 020304 GE 0042		
Batch: 2022 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 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. 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)	30

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 020401 GE 4004		
Batch: 2022 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. 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.	**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), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Nelson, D. L.; Cox, M. M. Lehninger's Principles of Biochemistry 7th 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 020402 GE 0042		
Batch: 2022 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 020403 GE 4004		
Batch: 2022 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. **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.	**15**

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 (EH3), 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** 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 $(NPCl_2)_3$.	**15**

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 020404 GE 0042		
Batch: 2022 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.

5. 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

6. 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

7. 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

8. 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)**

9. APPENDICES

- **Curricular Reforms — Extracts from National Education Policy-2020**