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. 2021)

DEPARTMENT OF CHEMISTRY
SCHOOL OF BASIC SCIENCES

Approved by :	**BOS**	**School Board**	**Academic Council**
Approval Status :	√	√	✓
Approval Date :	09-09-2021	20-09-2021	12-10-2021

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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	% of Courses
1	**Core Courses (CC)**	Compulsory Courses (CC)	84	56.75
2	**Elective Courses (EC)**	Discipline Specific Elective Courses (DSE)	24	16.21
		Generic Elective Courses (GE)	24	16.21
3	**Ability Enhancement Courses (AEC)**	Ability Enhancement Compulsory Courses (AECC)	8	5.40
		Ability Enhancement Elective (Skill Based) (SEC)	8	5.40
			148	**100**

Course Structure (Chemistry Major)

Details of courses for first three years

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

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

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

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

First Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester I								
1		Inorganic Chemistry-I: Atomic Structure & Chemical Bonding-I		CC	4	0	0	4
2		Physical Chemistry-I: States of Matter & Ionic Equilibrium		CC	4	0	0	4
3		Inorganic Chemistry Practical-I		CC	0	0	4	2
4		Physical Chemistry Practical-I		CC	0	0	4	2
5		Physics-I: Mechanics		GE	4	0	0	4
6		Physics Practical-I		GE	0	0	4	2
7		English Communications / Sanskrit		AECC	4	0	0	4
					Total Credit 22			
Semester II								
1		Organic Chemistry-I: Basics & Hydrocarbons		CC	4	0	0	4
2		Physical Chemistry-II: Thermodynamics & its Applications		CC	4	0	0	4
3		Organic Chemistry Practical-I		CC	0	0	4	2
4		Physical Chemistry Practical-II		CC	0	0	4	2
5		Physics-II: Waves and Optics		GE	4	0	0	4
6		Physics Practical-II		GE	0	0	4	2
7		Environmental Science/ Sanskrit		AECC	4	0	0	4
					Total Credit 22			

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

Second Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester III								
1		Inorganic Chemistry-II: s and p-Block Elements		CC	4	0	0	4
2		Organic Chemistry-II: Oxygen Containing Functional Groups		CC	4	0	0	4
3		Physical Chemistry-III: Phase Equilibria & Chemical Kinetics		CC	4	0	0	4
4		Inorganic Chemistry Practical-II		CC	0	0	4	2
5		Organic Chemistry Practical-II		CC	0	0	4	2
6		Physical Chemistry Practical-III		CC	0	0	4	2
7		Physics-III		GE	4	0	0	4
8		Physics Practical-III		GE	0	0	4	2
9		Pharmaceutical Chemistry/any other		SEC	4	0	0	4
					Total Credit 28			
Semester IV								
1		Inorganic Chemistry-III: Coordination Chemistry		CC	4	0	0	4
2		Organic Chemistry-III: Heterocyclic Chemistry		CC	4	0	0	4
3		Physical Chemistry-IV: Electrochemistry		CC	4	0	0	4
4		Inorganic Chemistry Practical-III		CC	0	0	4	2
5		Organic Chemistry Practical-III		CC	0	0	4	2
6		Physical Chemistry Practical-IV		CC	0	0	4	2
7		Physics-IV		GE	4	0	0	4
8		Physics Practical-IV		GE	0	0	4	2
9		Pesticide Chemistry/any other		SEC	4	0	0	4
					Total Credit 28			

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

Third Year

Sr. No	Course No	Course Name	Course Code	Course Type (Opted)	L	T	P	Credit
					Hrs.			
Semester V								
1		Organic Chemistry-IV: Biomolecules		CC	4	0	0	4
2		Physical Chemistry-V: Quantum Chemistry & Spectroscopy		CC	4	0	0	4
3		Organic Chemistry Practical-IV		CC	0	0	4	2
4		Physical Chemistry Practical-V		CC	0	0	4	2
5		Discipline Specific Elective -1		DSE	4	0	0	4
6		Discipline Specific Elective -2		DSE	4	0	0	4
7		Discipline Specific Elective Practical-1		DSE	0	0	4	2
8		Discipline Specific Elective Practical-2		DSE	0	0	4	2
					Total Credit 24			
Semester VI								
1		Inorganic Chemistry-IV:		CC	4	0	0	4
2		Organic Chemistry-V:		CC	4	0	0	4
3		Inorganic Chemistry Practical-IV:		CC	0	0	4	2
4		Organic Chemistry Practical-V:		CC	0	0	4	2
5		Discipline Specific Elective -3		DSE	4	0	0	4
6		Discipline Specific Elective -4		DSE	4	0	0	4
7		Discipline Specific Elective Practical-3		DSE	0	0	4	2
8		Discipline Specific Elective Practical-4		DSE	0	0	4	2
					Total Credit 24			

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

Total Credit (for 03 Years) = 148

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

LIST of COURSES

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

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

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

1. Applications of Computers in Chemistry (4) + Lab (4)
2. Analytical Methods in Chemistry (4) + Lab (4)
3. Molecular Modelling & Drug Design (4) + Lab (4)
4. Novel Inorganic Solids (4) + Lab (4)
5. Polymer Chemistry (4) + Lab (4)
6. Research Methodology for Chemistry (5) + Tutorials (1)
7. Green Chemistry (4) + Lab (4)
8. Industrial Chemicals & Environment (4) + Lab (4)
9. Inorganic Materials of Industrial Importance (4) + Lab (4)
10. Instrumental Methods of Analysis (4) + Lab (4)
11. Dissertation

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

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

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

Generic Elective Papers (GE) (Minor-Physics)

1. Mechanics
2. Waves and Optics
3. Electricity and Magnetism
4. Mathematical Physics I
5. Thermal Physics
6. Elements of modern Physics

Ability Enhancement Courses (AEC):

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

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

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

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

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

Generic Elective Papers (GE) (Minor-Chemistry)

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

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

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

8. COURSES

Course No:	Course Name: Inorganic Chemistry-I: Atomic Structure & Chemical Bonding-I				Course Code:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc. Chemistry	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.** **Pre-requisite of course:** Basic knowledge 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	15

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

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

Suggested Readings:

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

Course No:	Course Name: Inorganic Chemistry Practical-I				Course Code:		
Batch: 2021 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: Physical Chemistry-I				Course Code:		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry)	**Semester:** I	**L** 4	**T** 0	**P** 2	**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	15

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

	Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.	

Suggested Readings:

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

Course No:	Course Name: Physical Chemistry Practical-I				Course Code:		
Batch: 2021 onwards	**Programme:** Integrated B.Sc.-M.Sc.(Chemistry	**Semester:** I	**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	30

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

Suggested Readings:

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

Course No:	Course Name: English Communications				Course Code:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.** **Pre-requisite of course:** None					
Course Objective	*The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in the vital communication skills which should be integral to personal, social and professional interactions.*						
Course Outcomes:	After completing this course, student is expected to develop the following skills: **CO1**: Ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. **CO2**: Enhancement in effective communication. **CO3**: Various dimensions of communication skills. **CO4:** Enhancement in writing skills such as report writing, note-taking etc.						

COURSE SYLLABUS

NOTE:

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

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

Unit No.	Contents	Contact Hrs.
I	**INTRODUCTION AND COMMUNICATION** Introduction: Theory of Communication, Types and modes of Communication Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication.	15
II	**SPEAKINGSKILLS** Speaking Skills: Monologue, Dialogue, Group Discussion, Effective Communication/ Mis-Communication, Interview, Public Speech	15

III	**READINGANDUNDERSTANDING** Reading and Understanding, Close Reading, Comprehension, Summary Paraphrasing, Analysis and Interpretation, Translation (from Indian language to English and vice-versa), Literary/Knowledge Texts	15
IV	**WRITINGSKILLS** Writing Skills, Documenting, Report Writing, Making notes, Letter writing	15

Suggested Readings:

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

Course No:	Course Name: Sanskrit				Course Code:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** I	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration: 3 Hrs.** **Pre-requisite of course:** None					

Course Objective/ उद्देश्यः	**1. संस्कृतेतर-विषयाणामध्येतृभ्यः संस्कृताध्ययनाय सौकर्योत्पादनम्; 2. भारतीयज्ञानसंपदाधारभूतानां वेदादि-शास्त्राणामुपनिषदां च रुचिरुत्पादनम्; 3. संस्कृतेनोपनिबद्धानां नीतिवाक्यानां गीतायां वर्णितस्य कर्मयोगस्य च तत्त्व-संधारणाय यत्नः; 4. सामान्य-भाषाविज्ञानस्य परिचयः।**
Course Outcomes/ पाठ्यक्रमाध्ययनस्य फलम्	After completing this course, student is expected to develop the following skills: **CO1**: अध्येतारः वेदादि-शास्त्राणामुपनिषदां च तत्त्वान् ज्ञात्वा स्वाध्याय प्रयत्नशीलाः भवेयुः। **CO2**: व्यावहारिकदृष्ट्या संस्कृतज्ञानेन अन्यविषयाणामध्येतारः तत्तद् स्वविषयानुगुणं संस्कृतभाषायामुपलभ्यमानानां ग्रन्थानां प्रति यत्नशीलाः स्युः। **CO3**: वेदोपनिषत्–गीता–नीतिशास्त्र–भाषाशास्त्रादीनां विषयाणां सम्यगध्ययनेनास्माकं पूर्वजानां वैदुष्येण परिचयः संजायेत। **CO4:** भारतीय-चिन्तनपरम्परायाः समृद्धिं ज्ञातुमयं पाठ्यक्रमः प्रकृष्टमाध्यमः संजायेत।

पाठ्यक्रमः

मन्त्राणां सन्दर्भानां श्लोकानां च व्याख्या सारसंक्षेपश्च –

NOTE:

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

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

Unit No.	Contents	Contact Hrs.
I	**घटकम्-1**: **(क) यजुर्वेदः (34. 1-6)-शिवसंकल्पमन्त्राः; (ख) तैत्तिरीयोपनिषद् - शिक्षावल्ली (अनुशासनोपनिषद्)**	15
II	**घटकम्-2**: **भर्तृहरिः- नीतिशतकम्** : **1-50 श्लोकाः**	15

III	**घटकम्-3: भगवद्गीता – तृतीयाध्यायः (कर्मयोगः)**	15
IV	**घटकम्-4: सामान्यभाषाविज्ञानम्- (क) वर्णमाला, वर्णानाम् उच्चारणस्थानानि प्रयत्नाश्च; (ख) भाषाविज्ञानस्य सामान्यः परिचयः, भाषापरिवर्तनस्य कारणानि, अर्थपरिवर्तनस्य कारणानि च**	15

अनुशंसितग्रन्थाः -

1. उवव्ट-महीधर, शुक्लयजुर्वेदभाष्य, मोतीलाल बनारसीदास, दिल्ली, 2007

2. स्वामी दयानन्द सरस्वती, यजुर्वेदभाष्य, सम्पा० ब्रह्मदत्त जिज्ञासु, रामलाल कपूर ट्रस्ट, सोनीपत (हरियाणा)

3. तैत्तिरीयोपनिषद्, हिन्दी व्याख्याकार - स्वामी प्रखर प्रज्ञानन्द सरस्वती, काशी, 2013

4. भर्तृहरि, नीतिशतक, सम्पादक एवं हिन्दी व्याख्याकार - जनार्दन शास्त्री पाण्डेय, मोतीलाल बनारसीदास, दिल्ली, 2014

5. नीतिशतकम्, 'नीतिपथ' हिन्दी व्याख्याकार - राजेश्वर शास्त्री मुसलगाँवकर, चौखम्भा, वाराणसी

6. श्रीमद्भगवद्गीता (हिन्दी अनुवाद सहित), गीता प्रैस, गोरखपुर, 2015

7. श्रीकृष्ण त्रिपाठी, श्रीमद्भगवद्गीता (द्वितीय, तृतीय एवं चतुर्थ अध्याय), 2005

8. देवीदत्त शर्मा, भाषिकी और संस्कृत भाषा, हरियाणा साहित्य अकादमी, चण्डीगढ़, 1990

9. कपिलदेव द्विवेदी, भाषा-विज्ञान एवं भाषा-शास्त्र, विश्वविद्यालय प्रकाशन, चौक, वाराणसी, 2012

10. कर्णसिंह, भाषाविज्ञान, साहित्य भण्डार, मेरठ

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

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

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

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

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

COURSE SYLLABUS

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

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

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

Suggested Readings:

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

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

COURSE SYLLABUS

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

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

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

Suggested Readings:

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

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

COURSE SYLLABUS

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

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

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

Suggested Readings:

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

Course No:	Course Name: Physical Chemistry Practical-II				Course Code:		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credit**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Integrated Chemistry	II	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	**30**

	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.	

Suggested Readings:

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

Course No:	Course Name: Environmental Science				Course Code:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** II	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** 3 Hrs. **Pre-requisite of course:** None					

Course Objective	*To aware the students the need for sustainable development, problems of pollution, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer, loss of biodiversity and need of worldwide efforts in its conservation.*
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: The students will get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its conservation and development. **CO2**: The understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach. **CO3**: To know about the local environmental issues, movements and an important role to minimize the impact of these aspects. **CO4**: Knowledge about the types of pollution and pollution control.

COURSE SYLLABUS

NOTE:

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

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

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

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

Suggested Readings:

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

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

COURSE SYLLABUS

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

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

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

	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).	
IV	**ALIPHATIC HYDROCARBONS** Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure. **Alkanes:** (Upto 5 Carbons) Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. **Alkynes**: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$	14

Suggested Readings:

1. J. Singh, L.D.S. Yadav, Organic Chemistry (Volume I), 14th Edition, Pragati Prakashan, 2019.
2. T.W. Graham Solomon, C.B. Fryhle, & S.A. Dnyder, Organic Chemistry, John Wiley & Sons, 2014.
3. J.E. McMurry, Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning Edition, 2013.
4. S. M. Mukerji, S. P. Singh, K.P.Kapoor and R. Das, Organic Chemistry (Volume I), 2nd Edition, New Age 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:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** II	**L** 0	**T** 0	**P** 4	**Credit** 2	**Contact Hrs. per Week: 04** **Total 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	30

	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. (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:		
Batch: 2021 Onwards	**Programme:** Integrated B.Sc.-M.Sc.	**Semester:** **II**	**L** 4	**T** 0	**P** 0	**Credits** 4	**Contact Hrs. per Week: 04** **Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** 30 Marks **TEE:** 70 Marks		**Examination Duration:** **3 Hrs.** **Pre-requisite of course:** None					
Course Objective	*To provide basic knowledge of chemistry of aromatic hydrocarbons, alky and aryl halides, alcohols, phenols, ethers and carbonyl compounds. To provide basic understanding of chemical energetics, chemical equilibrium and ionic equilibria.*						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Basics of chemical energetics. **CO2**: Basics of chemical equilibrium and ionic equilibria. **CO3**: Chemistry of aromatic hydrocarbons, alky and aryl halides. **CO4**: Chemistry of alcohols, phenols, ethers and carbonyl compounds.						

COURSE SYLLABUS

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

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

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

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

Suggested Readings:

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

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

COURSE SYLLABUS

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

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

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

Suggested Readings:

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

9. TEACHING-LEARNING PROCESS

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

10. IMPLEMENTATION OF BLENDED LEARNING

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

Key features of Blended Learning

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

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

11. ASSESSMENT AND EVALUATION

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

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

- Seminar Presentations
- Review of Literature

Collaborative Assignments