

**Dolphin (PG) Institute of Biomedical & Natural Sciences
Dehradun, Uttarakhand-248007**

(An Autonomous Institute)

NAAC Accredited A⁺ (2nd cycle)



(Affiliated with H.N.B. Garhwal Central University, Srinagar, Srinagar Garhwal)

Ordinance & Syllabus

of

B.Sc. Chemistry Honours/Research

Four Years (8 Semesters Programme)

**Based upon NEP-2020 and Curriculum frame work for
Graduate Programme-2024**

Effective from

Academic Session

2024-2025

Department of Pharmaceutical Chemistry & Chemistry

Acknowledgement

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We would like to acknowledge the contributions of our Board of Studies (BOS) members, whose expertise and guidance have been instrumental in shaping the curriculum. Our sincere appreciation goes to the students and alumni for their feedback and suggestions, which have been incorporated to make this syllabus more relevant and effective.

Dr. Deepak Kumar

**(Chairperson, Board of Studies in
Pharmaceutical Chemistry & Chemistry)**

Board of Studies in Pharmaceutical Chemistry & Chemistry

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Deepak Kumar	Chairperson	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
All Faculty Members of the Department			
1	Dr. Versha Parcha	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
2	Dr. Raju	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
3	Dr. Ritu Singh	Member	Dolphin PG Institute of Biomedical and Natural Sciences Dehradun
Subject Expert nominated by Vice-Chancellor			
1	Prof. Anjana Srivastava	Nominated Member	Department of Chemistry, G. B. Pant University of Agriculture & Technology, Pantnagar
Subject experts			
1	Prof. V. K. Varshney	Nominated Member	HOD, Department of Chemistry, Forest Research Institute, Dehradun
2	Dr. Rakesh Joshi	Nominated Member	Department of Chemistry, Sri Dev Suman University, Rishikesh.
Representative from Industry/corporate sectors			
1	Dr. Vinod Tiwari	Nominated Member	Plant Head, Planet Herb Life Sciences Ltd. Dehradun
Alumnus			
1	Mrs. Kavita	Nominated Member	Ms. PGT, Doon Haritage School, Dehradun

Vision, Mission and Core Values of the Institute

Vision

Lead the youth on a journey of knowledge and innovation, along with cultivating a sense of responsibility, perseverance, integrity and fellowship to fortify society on a global scale.

Mission

1. Steadfastly delivering holistic and ethical development of students with education.
2. Focusing on learning inside the classroom, and beyond, by nurturing qualities of leadership, teamwork, self-agency and ingenuity in all the lives we touch.

Core Values

With encouragement and enthusiasm in each tireless, dedicated step into a future that embodies the institute's novel motto of "**Honours Beyond Education**".

Vision and Mission of the Department

Our vision is to strengthen our standing as an outstanding centre for interdisciplinary research and teaching that draws the brightest students with its quality teaching and creative research to foster the development of new talents

Our mission is to equip our students to take on the challenges of both the academic and industrial sectors; we provide unique and pertinent graduate and postgraduate education in the chemical and pharmaceutical sciences. We conduct scholarly research and academic work related to the current problems facing society and industry

About the Programme

The undergraduate curriculum for the B. Sc. Chemistry (Hons.) program aligns meticulously with the guidelines set forth by the National Education Policy of 2020, emphasizing the Curriculum and Credit Framework. This curriculum is designed to deliver a comprehensive and rigorous education, seamlessly blending theoretical knowledge with practical application and research exposure.

The B. Sc. Chemistry (Hons.) program is structured to provide students with the requisite knowledge and skills essential for success in the field of chemistry, enabling them to make meaningful contributions to scientific endeavors and tackle the contemporary challenges of the 21st century. Throughout the duration of the program, students engage in experiential learning experiences, primarily conducted in state-of-the-art laboratories. These hands-on sessions empower students to conduct experiments, analyze data, and develop a profound understanding of chemical principles.

Moreover, the curriculum is meticulously crafted to facilitate students' mastery of theoretical concepts in chemistry while concurrently honing their proficiency in chemical analysis methodologies through a diverse array of laboratory courses. By leveraging cutting-edge analytical instruments and methodologies, students are equipped with the competencies necessary to excel in chemical analysis and characterization procedures.

In essence, the B. Sc. Chemistry (Hons.) curriculum not only imparts theoretical knowledge but also nurtures practical skills and fosters a deep appreciation for scientific inquiry. Through this holistic approach to education, students are empowered to become adept problem-solvers and innovative thinkers, well-prepared to navigate the complexities of the scientific landscape and contribute meaningfully to the advancement of knowledge in chemistry.

Eligibility: 12th (PCB/PCM/Chemistry as one of the subject or equivalent from any state board) with 45% marks

Objectives of the Programme are as follows

The bachelor's degree program in chemistry aims to accomplish the following objectives:

- Provide students with a comprehensive and well-rounded understanding of chemistry, encompassing key concepts, principles, and theories.
- Cultivate students' proficiency in problem-solving, enabling them to tackle both theoretical and applied chemistry challenges with confidence and expertise.

- Equip students with the requisite knowledge and skills to pursue further studies in chemistry or related multidisciplinary fields, fostering avenues for self-employment and entrepreneurship.
- Foster the holistic cognitive development of students by creating an environment conducive to their intellectual growth.
- Deliver the latest advancements in chemistry in a manner that supports students' core competencies and encourages discovery learning, integrating both theoretical knowledge and practical applications.
- Cultivate a sense of responsibility and civic consciousness in students, instilling in them basic domain-independent skills such as critical thinking and effective communication.
- Prepare graduates to excel in national and international competitive examinations, particularly the UGC-CSIR NET and UPSC Civil Services Examination, thereby opening up opportunities for further career advancement and academic pursuits.
- Through these objectives, the bachelor's degree program in chemistry endeavours to produce well-rounded, competent, and socially responsible individuals equipped to make significant contributions to the field of chemistry and society at large.

Possible career pathways

A degree in Chemistry opens doors to a diverse array of career opportunities, empowering graduates to make innovative contributions across various sectors, from environmental analysis to education, and beyond.

- A Bachelor of Science in Chemistry opens doors to a multitude of rewarding career paths across various sectors. Graduates in Chemistry are highly sought-after in industries such as environmental analysis, chemical manufacturing, research, and pharmaceuticals. Moreover, they have the opportunity to pursue advanced degrees for specialized roles, further expanding their career prospects.
- In the environmental analysis sector, graduates may find employment with companies like Environmental Resources Management (ERM) or the Environmental Protection Agency (EPA), where they contribute to assessing and mitigating environmental risks through chemical analysis and research.

- Chemistry graduates are also integral to the manufacturing of chemicals, with potential employers including companies like Dow Chemicals or BASF, where they play key roles in product development, quality control, and process optimization.
- Research positions are another avenue for chemistry graduates, with opportunities available at academic institutions such as universities, government research centers like Council of Scientific and Industrial Research, Indian Space Research Organisation (ISRO, ONGC, DRDO, ARS, TRDDC CSIR, Indian Oil Corporation Hindustan Unilever Limited Limited NASA or the National Institutes of Health (NIH) and commercial enterprises like Dr. Reddy's Laboratories, sun pharma, Pfizer, Merck, food and beverage industries, cosmetics, oil and petroleum enterprises, mineral extraction firms, chemical manufacturing companies, and clinical establishments, here, they engage in ground breaking research, developing novel molecules, advancing scientific understanding, and contributing to industries such as environmental science, materials science, and medicine.
- Additionally, many chemistry graduates choose to pursue careers in education, shaping the future of science as teachers in colleges, universities, and schools. Institutions such as Harvard University or local high schools provide platforms for graduates to inspire and mentor the next generation of scientists.

PROGRAMME OUTCOMES

PO-1 *Critical thinking and complex problem solving:* The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts

PO-2: *Creativity:* The Curriculum will develop creativity among student by applying skill based practical and theoretical knowledge.

PO-3: *Communication skills:* Chemistry graduates are expected to possess minimum standards of communication skills expected of a science graduate in the country. They are expected to read and understand information about chemistry from various sources and convey it to intended audience, both orally and in writing in an intelligible manner.

PO-4: *Communication Skills:* Physics Post graduates will demonstrate written and oral communication skills in communicating physics-related topics and the ability to write dissertations, reports, make effective presentations and documentation.

PO-5: Analytical reasoning and thinking: The student will be able to draw logical conclusions based on a group of observations, facts and rules.

PO-6: Research related skills: The programme will develop research skill by design a scientific experiment through statistical hypothesis testing.

PO-7: Coordinating/collaborating with others: Chemistry graduates will be able to collaborate effectively with others, including peers, colleagues, and interdisciplinary teams, to achieve common goals.

PO-8: Leadership readiness/qualities: Chemistry graduates will have an ability to develop the quality of leadership which will help them to be a part of any organization as well as create a positive energy in their work field to achieve any assigned target.

PO-9: Learning how to learn skills: Chemistry graduates will have a curiosity-driven and self-directed approach to learning, as well as the ability to ask insightful questions and explore new areas of knowledge.

PO-10: Digital and technological skills: Chemistry graduates should be proficient in the use of digital tools and information and communication technologies (ICT), including programming languages, simulation software, and data analysis tools.

PO-11: Multicultural competence and inclusive spirit: Chemistry Graduates will have acquisition of knowledge of the values and beliefs of multiple cultures and a global perspective to honour diversity.

PO-12: Value inculcation: Chemistry graduates will be aware of the global and national issues related to science and technology, as well as their roles and responsibilities as Indian and global citizens as well.

PO-13: Autonomy, responsibility, and accountability: Chemistry graduates will able to apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification and can work independently, and identify appropriate resources required for a task

PO-14: Environmental awareness and action: The curriculam provides students to demonstrate the acquisition of and ability to apply the knowledge, skills, attitudes, and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

PO-15: *Community engagement and service:* The students should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the well-being of society.

PO-16: *Empathy:* The Chemistry graduates will be able to demonstrate the ability to give regard to points of view of another individual or group, and to identify and understand other people's emotions.



Curriculum Structure

Semester	Major Courses – Core (MCC)	Minor course (MC) /vocational courses (VC)	Multidisciplinary courses (MD)	Skill Enhancement course (SEC)	Ability Enhancement courses (AEC)	Value Addition Courses (VAC)	Total credits acquired	Total credits required
I	Atomic Structure, Chemical Bonding and General Organic Chemistry	Choose Courses from DIBNS Pool (5)	Choose from DIBNS Pool (3)	Choose from DIBNS Pool (3)	Choose from DIBNS Pool (2)	Choose from DIBNS Pool (2)	20	20
II	Chemistry of 's' & 'p' Block Elements	Choose Courses from DIBNS Pool (5)	Choose from DIBNS Pool (3)	Choose from DIBNS Pool (3)	Choose from DIBNS Pool (2)	Choose from DIBNS Pool (2)	20	20
							40	40
Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate in Chemistry if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester								
III	Chemical Thermodynamics & Functional Organic Chemistry-I (5) Aliphatic and Aromatic Hydrocarbons (5)	Choose Courses from DIBNS Pool (5)	Choose from DIBNS Pool (3)		Choose from DIBNS Pool (2)		20	20
IV	Electrochemistry, Conductance and Solution (5) Functional Organic	Choose Courses from DIBNS Pool (5)		Choose from DIBNS Pool (3)	MOOCS/SWAYAM/NPTEL (2)	Choose from DIBNS Pool (2)	22	20

	Chemistry-II (5)							82	80
Students who opt to exit after completion of the second year and have secured 82 credits will be awarded the UG diploma in Chemistry, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year.									
V	Quantum and Surface Chemistry (5) Chemistry of 'd' and 'f' Block Elements (5) States of Matter and Solid State Chemistry (5)	<i>choose any one course from identified minor disciplines (5)</i>	-	Internship (2)	-	-	-	22	20
VI	Co-ordination Chemistry (5) Stereochemistry & Reaction Mechanisms (5) Chemistry of Natural Products (5)	<i>choose any one course from identified minor disciplines (5)</i>	-	-	-	-	-	20	20
	60	30 (24)						124	120
Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Chemistry after successful completion of three years, securing 124 credits									
VII	Advance Organic Chemistry (5) General Principles of Metallurgy, Noble Gases &	<i>choose any one course from identified minor disciplines (5)</i>	-	-	-	-	-	20	20

	Acids and Bases (5) Chemical Equilibrium, Ionic Equilibrium, Phase Equilibrium and Chemical Kinetics (5)							
VIII	Research Methodology (5)	<i>choose any one course from identified minor disciplines (5)</i>	-	Dissertation/ Research presentation (12)	-	-	22	20
	80	40 (32)	9	9+2int+12dis	8	6	166	160
Students will be awarded UG Degree (Honours with Research) in the Chemistry if, they secure 166 credits								
	Research Methodology (5)	<i>choose any one course from identified minor disciplines (5)</i>		Pesticide Chemistry(4) Fundamental of Heterocyclic Chemistry (4) Quantum Chemistry & Group Theory (4)			22	20
Students will be awarded UG Degree (Honours) in the Chemistry if, they secure 166 credits								

 **Courses:**

Major Discipline: The major discipline refers to the primary subject of study, and the degree will be granted in that specific field Chemistry students are required to earn 50% of the total credits through Chemistry Major (core) courses within the major discipline (Chemistry)

MAJOR COURSES OFFERED BY DEPARTMENT

For 3 years-60 credits
For 4 years-80 credits

Offered by the Chemistry Department for Chemistry Majoring Students

Semester	Course Name	Credits	Teaching Hours per week
I	Atomic Structure, Chemical Bonding and General Organic Chemistry	5 (4 L+1P)	6 hours
II	Chemistry of 's' & 'p' Block Elements	5 (4L+1T)	5 hours
III	Chemical Thermodynamics & Functional Organic Chemistry-I	5 (4L+1P)	6 hours
	Aliphatic and Aromatic Hydrocarbons	5 (4L+1P)	6 hours
IV	Electrochemistry, Conductance and Solution	5 (4L+1P)	6 hours
	Functional Organic Chemistry-II	5 (4L+1P)	6 hours
V	Quantum and Surface Chemistry	5 (4L+1T)	5 hours
	Chemistry of 'd' and 'f' block elements	5 (4L+1T)	5 hours
	States of Matter and Solid State Chemistry	5 (4L+1P)	5 hours
VI	Co-ordination Chemistry	5 (4L+1T)	5 hours
	Stereochemistry & Reaction Mechanisms	5 (4L+1T)	5 hours
	Chemistry of Natural Products	5 (4L+1P)	6 hours
VII	Advance Organic Chemistry	5 (4L+1T)	5 hours
	General Principles of Metallurgy, Noble Gases & Acids and Bases	5 (4L+1P)	6 hours
	Chemical Equilibrium, Ionic Equilibrium, Phase Equilibrium and Chemical Kinetics	5 (4L+1P)	6 hours
VIII	Research Methodology	5 (4L+1P)	6 hours
	Total Credits	80 credits	

Key Point:

Change of Major: A student can decide to continue the chosen major or change the major and minor at the end of the second semester or first year.

SEMESTER WISE MINOR/VOCATIONAL (CHEMISTRY) OFFERED BY DEPARTMENT

Course Title
Techniques in Essential Oil Production and Utilization
Professional Soap Production Techniques
Cosmetic Chemistry: Innovations and Entrepreneurship
Cosmetic Chemistry: From Formulation to Market
Basic Chemistry
Molecules of Life
Green Chemistry
Quantitative Analytical Methods
Fundamental of Analytical Chemistry
Fundamentals of Pharmaceutical Chemistry
Quantum Chemistry and Group Theory
Pesticide Chemistry
Fundamental of Heterocyclic Chemistry
Spectroscopy

MULTIDISCIPLINARY COURSES OFFERED BY DEPARTMENT

Course Title
Chemistry Essentials for Everyday Life
Environmental Chemistry-Pollution Control Strategies
Elements and Compounds

SKILL ENHANCEMENT COURSES (SEC) OFFERED BY DEPARTMENT

Course Title
Aromatherapy & Essential Oils
Herbal Drug Formulations

B. Sc Chemistry Honours/Research 1st Semester

Major Courses

Course Name	Atomic Structure, Chemical Bonding & General Organic Chemistry	L	T	P	C
Course Code	MJBCH-101	4	0	1	5

Course Objectives: This course provides an in-depth understanding of the fundamental concepts in chemistry, focusing on three main areas: atomic structure, chemical bonding, and general organic chemistry.

Course Outcomes:

CO1. Communicate effectively about atomic structure concepts, both orally and in writing, using appropriate scientific terminology. Synthesize knowledge of atomic structure to finding the applications in technology, medicine, and environmental science.

CO2. The study of ionic bonding provides students with a fundamental understanding of how and why ions form, the properties and behaviors of ionic compounds, and their significance in various fields of science and technology.

CO3. These outcomes equip students to apply their knowledge to predict chemical behavior, solve problems, and make informed decisions in practical contexts.

CO4. To Predict the number and arrangement of molecular orbitals based on the number of atomic orbitals on combining and Explain how molecular orbitals form through constructive and destructive interference of atomic orbitals.

CO5. This unit introduces the fundamental principles of organic chemistry, which focuses on the structure, properties, and reactions of organic compounds.

Unit I. Atomic Structure

12 Hrs

Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. 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 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers, orbital angular momentum and quantum numbers: n, l, m and s. Shape of atomic orbitals (s, p and d), nodal planes. Rules for filling electrons in various atomic orbitals, Electronic configurations of the atoms, Stability of half-filled and completely filled orbitals, concept of exchange energy, Anomalous electronic configurations.

Unit II. Ionic Bonding

14 Hrs

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.

Unit III. Covalent Bonding

12 Hrs

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.

Unit IV. Molecular Orbital Theory

12 Hrs

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 sp mixing) and heteronuclear diatomic molecules such as CO, NO and NO⁺. Comparison of VB and MO approaches.

Unit V. Physical Effects & Reactive Intermediates

10 Hrs

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, nitrenes, carbenes and free radicals.

Books Suggested

S. No.	Unit	Book Suggested
1	I	1.Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley 2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2	II	1.Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley 2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
3	III	1.Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley 2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
4	IV	1.Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley 2. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
5	V	1.Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.

		2. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
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Course Title: Lab - Atomic Structure, Chemical Bonding & General Organic Chemistry

Course Objectives: This lab course provides to students an experiential learning of the following experiment. The following experiments play an important role to understanding quantitative aspect of the substances in any solution, mixture or formulation.

Course Outcome:

CO1. Students learn about handling the instrument and how to use the glassware.

CO2. Develop the thinking to determination of the end point of the titration.

CO3. Students analyze and identify regarding unknown substances in a sample.

CO4. Create the thinking regarding to find out the concentration of the substances.

Titration

30 Hrs

1. Estimation of oxalic acid by titrating it with KMnO_4 .
2. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
3. Estimation of Fe (II) ions by titrating it with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal indicator.
4. Estimation of water of crystallization in Mohr's salt by titrating with KMnO_4 .
5. Element detection of nitrogen, sulphur and halogen in a given organic compounds.

Books Suggested

S. No.	Book Suggested
1	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Pandey, O.P, Bajpai, D.N., Giri, S. Practical Chemistry – S Chand, 1972.
2	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Pandey, O.P, Bajpai, D.N., Giri, S. Practical Chemistry – S Chand, 1972.
3	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Pandey, O.P, Bajpai, D.N., Giri, S. Practical Chemistry – S Chand, 1972.
4	1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012. 2. Pandey, O.P, Bajpai, D.N., Giri, S. Practical Chemistry – S Chand, 1972.

B. Sc Chemistry Honours/Research 2nd Semester

Major Courses

Course Name	Chemistry of 's' and 'p' Block Elements	L	T	P	C
Course Code	MJBCH-102	4	0	1	5

Course Objectives: The course "Chemistry of 's' and 'p' Block Elements" provides a comprehensive study of the chemical properties, reactions, and applications of the elements belonging to the 's' and 'p' blocks of the periodic table.

Course Outcomes:

CO1. Students should have gained a deep understanding of the fundamental principles and practical applications of alkali and alkaline earth metal chemistry, along with the analytical and problem-solving skills necessary to pursue further studies or careers in chemistry, environmental science, and related fields

CO2. Explore the industrial and commercial applications of Boron and its compounds, such as in borosilicate glass (Pyrex), boron fibers (used in composites), and boron neutron capture therapy.

CO3. Students analyze the trends in chemical reactivity within the group, focusing on similarities and differences in their chemical behavior.

CO4. Discuss the formation of ions and compounds involving Nitrogen and its family members, including ammonia, nitrides, phosphates, and arsenides.

CO5. To learn the industrial and commercial applications of Oxygen and its compounds, such as in steel production (oxygen steelmaking), water treatment (ozone), and inorganic chemicals.

CO6. Students to analyze the environmental impact of Group 16 elements, particularly in terms of pollution and remediation efforts.

Unit I. Alkaline & Alkaline Earth Metals

10 Hrs

Introduction, occurrence, extraction, major uses of the alkali metals and their compounds. Physical properties, atomic spectra and flame tests. The metals: appearance and reactivity. Oxides and hydroxides: oxides, peroxides, superoxides, diagonal relationship.

Unit II. Boron Family (III A Group)

10 Hrs

Introduction, occurrence, extraction and uses. Physical properties: electronic configurations and oxidation states. The elements: appearance, structure of the elements, reactivity. Simple hydrides, Halides and complex halides, Oxides and Hydroxide.

Unit III. Carbon Family (IV A Group)

12 Hrs

Introduction, occurrence, extraction and uses, physical properties, allotropes of carbon, graphite, diamond, fullerenes and carbon nanotubes. Structure and chemical properties of Si, Ge, Sn and Pb. Hydrides, carbides and halides: carbon halides and silicon halides. Silicons, and cyanogens.

Unit IV. Nitrogen Family (V A Group)

10 Hrs

Introduction, occurrence, extraction and uses. Physical properties, Hydrides: trihydrides and hydrides, halides, oxohalides. Oxides of nitrogen: N_2O , NO , N_2O_3 , N_2O_4 and N_2O_5 . Oxoacids of nitrogen: $H_2N_2O_2$, HNO_2 , HNO_3 . Oxoacids of phosphorus: H_3PO_2 , H_3PO_3 , H_3PO_4 , $H_4P_2O_6$.

Unit V. Oxygen Family (VI A Group)

10 Hrs

Introduction, occurrence, extraction and uses. Physical properties. Dioxygen, ozone, allotropes of sulphur and reactivity, Hydrides: H_2O_2 , H_2O . halides and oxohalides and oxides of sulphur. Oxoacids: $H_2S_2O_4$, H_2SO_3 , $H_2S_2O_5$, $H_2S_2O_6$, $H_2S_2O_4$, H_2SO_4 , $H_2S_2O_8$ and H_2SO_5 .

Unit – VI Halogen Elements

8 Hrs

Introduction, occurrence, extraction and uses. Physical properties, interhalogen compounds and polyhalogen ions.

S. No.	Unit	Book Suggested
1	I	1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
2	II	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	III	1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
4	IV	1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
5	V	1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991. 2. Cotton, F.A., Wilkinson, G. & Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.

6	VI	<p>1. Puri, Sharma and Kaliya. Inorganic Chemistry, 2017.</p> <p>2. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.</p>
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Course Title: Lab - Chemistry of 's' and 'p' Block Elements

Course objectives: This lab course covers qualitative analysis of acid and basic radicals.

Course Outcome:

CO1. Students learn about finding the process to detect acidic and basic radicals or ions from the given inorganic mixture.

CO2. This outcome of identifying acidic and basic radicals lies in a deeper understanding of their chemical behavior

CO3. This method determines the concentration of these radicals in a sample by measuring the amount of titrant required to neutralize them.

CO4. Identifying these radicals allows to predict how these ions will interact in solution.

Inorganic Chemistry

30 Hrs

Qualitative analysis of inorganic mixtures of the following ion:

Semi-micro qualitative analysis using H₂S of mixtures - not more than four ionic species (two anions and two cations and excluding insoluble salts) out of the following:

Cations: NH⁴⁺, Pb²⁺, Ag⁺, Bi³⁺, Cu²⁺, Cd²⁺, Sn²⁺, Fe³⁺, Al³⁺, Co²⁺, Cr³⁺, Ni²⁺, Mn²⁺, Zn²⁺, Ba²⁺, Sr²⁺, Ca²⁺, K⁺.

Anions: CO₃²⁻, S²⁻, SO₃²⁻, S₂O₃²⁻, NO₃⁻, CH₃COO⁻, Cl⁻, Br⁻, I⁻, NO₂⁻, SO₄²⁻, PO₄³⁻, BO₃³⁻, C₂O₄²⁻, F⁻.

S. No.	Book Suggested
1	<p>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 edition, 1996.</p> <p>2. Pandey, O.P, Bajpai, D.N., Giri, S. Practical Chemistry – S Chand, 1972.</p>

B. Sc Chemistry Honours/Research 1st Semester

Minor Courses

Course Name	Techniques in Essential Oil Production and Utilization	L	T	P	C
Course Code	MIBCH-101	4	0	1	5

Course Objectives: Acquiring advanced knowledge, practical skills, and experience in the art and science of is the aim of the Techniques in Essential Oil Production and Utilization Course. The goal of this course is to provide students a thorough grasp of essential oils, their medicinal uses, and real-world applications. The course will teach participants how to create blends, use aromatherapy techniques, and incorporate aromatherapy into a variety of holistic treatments.

Course Outcome:

CO1. Extraction Techniques

Students will acquire practical knowledge and skills in various essential oil extraction methods, including steam distillation, cold pressing, and solvent extraction.

CO2. Quality Control and Assurance

They will understand regulatory standards, perform physico-chemical analyses, and evaluate the chemical profiles of essential oils to maintain high standards in production.

CO3. Formulation and Application

They will understand the chemical properties and therapeutic effects of various essential oil constituents and learn to create customized blends for skincare, health, and home applications.

CO4. Entrepreneurship and Business Development

Students will be equipped with the knowledge and skills to start and manage a business in essential oil production and utilization.

Course Content

Unit I. Introduction to Essential Oils

12 Hrs

Definition and classification of essential oils Historical overview of essential oil usage
Chemical composition of essential oils: terpenes, alcohols, esters, etc. Factors influencing the chemical profile of essential oils: plant species, essential oil constituents and their therapeutic properties

Unit II. Extraction Methods

18 Hrs

Steam Distillation: Principles, process, equipment, and optimization for yield and quality.**Cold Pressing:** Techniques for extracting essential oils from citrus fruits, benefits, and limitations**Solvent Extraction and CO₂ Extraction:** Use of solvents and supercritical CO₂ for delicate plant materials, safety, and environmental considerations.**Hydrodistillation and Enfleurage.** Basic principle , know how & comparison of yields and quality.**Quality Control and Purity Assessment:** Techniques for assessing the quality and purity of extracted oils, including GC-MS.**Unit III Practical Applications of Essential Oils**

17 Hrs

Skincare and beauty applications: facial creams body oils.**Hair care product****Environmental use room sprays****Natural cleaning products** and insect repellents Health and wellness applications: pain relief, stress management, and immune support**Unit IV**

13 Hrs

Sustainable Production

Practices for cultivating aromatic plants in an environmentally friendly manner. Current trends in the essential oil market and challenges related to sustainability, Effects of essential oil production on ecosystems and strategies for minimizing negative impacts.

Book Suggested:

S. No	Unit	Books Suggested
1	I	1. The Complete Book of Essential Oils and Aromatherapy" by Valerie Ann Worwood New World Library Edition 115 October 2016 2. Essential Oils: Chemistry and Pharmacology by K. Husnu Can Baser and Gerhard Buchbauer, 2020, ISBN: 978-0367578162 3. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992
2	II	1. Essential Oil Safety: A Guide for Health Care Professionals" by Robert Tisserand and Rodney Young 2. Essential Oils: Chemistry and Pharmacology by K. Husnu Can Baser and Gerhard Buchbauer, 2020, ISBN: 978-0367578162 3. The Art of Aromatherapy: The Healing and Beautifying Properties of the Essential Oils of Flowers and Herbs" by Robert Tisserand

3	III	1. The Art of Aromatherapy: The Healing and Beautifying Properties of the Essential Oils of Flowers and Herbs" by Robert Tisser 2. Essential Oils: Chemistry and Pharmacology by K. Husnu Can Baser and Gerhard Buchbauer, 2020, ISBN: 978-0367578162
4	IV	1. Sustainable Sourcing: A Guide to Finding, Evaluating, and Utilizing Sustainable Products and Ingredients" by Rosalee de la 2. Green Chemistry: Theory and Practice" by Paul T. Anastas and John C. Warner.

Course Title: Lab - Techniques in Essential Oil Production and Utilization

Experiments based on theory paper:

30 Hrs

Laboratory shall constitute of the following:

1. Unit I: Perform different extraction methods of a selected plant material.
2. Unit II: Perform Physico-chemical analysis essential oils.
3. Unit III: Create facial Creams, Soap, body oils, and hair care products using essential oils.

Book suggested:

S. No	Unit	Books Suggested
1	I	1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414
2	II	1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414
3	III	1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414

B. Sc Chemistry Honours/Research 2nd Semester

Minor Courses

Course Name	Professional Soap Production Techniques	L	T	P	C
Course Code	MIBCH-102	4	0	1	5

Course Objectives: To equip students with the foundational knowledge of soap making & hands-on experience with soap making methods and guide students in developing a small-scale soap production business, including marketing and compliance with industry regulations.

Course Outcomes:

CO1. Practical Soap-Making Skills

Students will acquire hands-on skills in making various types of soaps, including cold process, hot process, and melt-and-pour soaps.

CO2. Understanding Ingredient Properties

Students will develop a comprehensive understanding of the properties of different soap-making ingredients, such as oils, butters, fragrances, and additives.

CO3. Safety and Quality Assurance

Students will learn and apply safety precautions necessary for producing soaps, including proper handling of caustic substances. They will understand the importance of maintaining high-quality standards in soap production to ensure customer satisfaction and compliance with industry regulations.

CO4. Business Setup and Marketing Strategies

Students will learn how to establish and market a soap-making business, including sourcing ingredients, understanding and adhering to labeling regulations, and developing effective sales strategies for different market channels.

Course Content

Unit I. Introduction to Soap Making

15 Hrs

Basics of Soap Making History and Evolution of Soap Overview of Different Types of Soap (Cold Process, Hot Process, Melt and Pour) Essential Equipment and Safety Measures

Ingredients and Their Functions Oils and Fats: Types and Properties Additives: Fragrances, Colors, and Botanicals Cold Process Soap Making Step-by-Step Cold Process Soap Making Handling and Mixing Ingredients Safely, Troubleshooting Common Issues

Unit II. Advanced Soap Making Techniques 15 Hrs

Hot Process Soap Making: Understanding Hot Process Techniques Benefits and Challenges Step-by-Step Hot Process Soap Making Melt and Pour Soap Making: Basics of Melt and Pour Method Customizing with Additives Creative Techniques and Designs Soap Curing and Packaging: Proper Curing Techniques for Different Soaps Packaging Options and Considerations Labeling and Compliance with Regulations

Unit III. Specialty Soaps and Formulations 16 Hrs

Natural and Organic Soaps: Selecting Natural Ingredients, Formulating Organic Soap Recipes Certification and Labeling Requirements

Medicinal and Functional Soaps Incorporating Medicinal Herbs and Essential Oils Designing Soaps for Specific Skin Conditions

Artistic and Decorative Soaps: Techniques for Swirls, Layers, and Embeds, Using Molds and Stamps Creatively Advanced Design Techniques

Unit IV. Business and Marketing in Soap Production: 14 Hrs

Starting a Soap Making Business, Business Planning and Market Research, Setting Up Your Production Space, Sourcing Ingredients and Supplies

Marketing and Sales Strategies: Building Your Brand Identity, Online and Offline Marketing Technique

Books Suggested:

S. No	Unit	Books Suggested
1	I	1. Soap Maker's Workshop: The Art and Craft of Natural Homemade Soap" by Dr. Robert S. McDaniel and Katherine J. McDanie @010 IKrause Publication 2. Soap Maker's Workshop: The Art and Craft of Natural Homemade Soap" by Dr. Robert S. McDaniel and Katherine J. McDanie @010 IKrause Publication
2	II	1. Soap Crafting: Step-by-Step Techniques for Making 31 Unique Cold-Process Soaps" by Anne-Marie Faiola Storey Publishing LLC 2013 2. Soap Maker's Workshop: The Art and Craft of Natural Homemade Soap" by Dr. Robert S. McDaniel and Katherine J. McDanie @010 IKrause Publication

3	III	1 Soap Crafting: Step-by-Step Techniques for Making 31 Unique Cold-Process Soaps" by Anne-Marie Faiola Storey Publishing LLC 2013 2 Pure Soapmaking: How to Create Nourishing, Natural Skin Care Soaps" by Anne-Marie Faiola Storey Publishing 2016
4	IV	1 Pure Soapmaking: How to Create Nourishing, Natural Skin Care Soaps" by Anne-Marie Faiola Storey Publishing 2016 2 The Natural Soapmaking Book for Beginners: Do-It-Yourself Soaps Using All-Natural Herbs, Spices, and Essential Oils" by Kelly Cable Althea Pr 2017

Course Title: Lab - Professional Soap Production Techniques

Experiments based on theory paper:

30 Hrs

Laboratory shall constitute of the following

Unit I: Preparation of Natural and Organic Soaps

Unit II: Medicinal and Functional Soaps

Unit III: Artistic and Decorative Soaps

Books Suggested

S.No	Unit	Books Suggested
1	I	1. Soap Maker's Workshop: The Art and Craft of Natural Homemade Soap" by Dr. Robert S. McDaniel and Katherine J. McDanie @010 IKrause Publication 2. The Natural Soap making Book for Beginners: Do-It-Yourself Soaps Using All-Natural Herbs, Spices, and Essential Oils" by Kelly Cable Althea Pr 2017
2	II	1. Soap Crafting: Step-by-Step Techniques for Making 31 Unique Cold-Process Soaps" by Anne-Marie Faiola Storey Publishing LLC 2013 2. Pure Soapmaking: How to Create Nourishing, Natural Skin Care Soaps" by Anne-Marie Faiola Storey Publishing 2016
3	III	1. Soap Crafting: Step-by-Step Techniques for Making 31 Unique Cold-Process Soaps" by Anne-Marie Faiola Storey Publishing LLC 2013 2. Pure Soapmaking: How to Create Nourishing, Natural Skin Care Soaps" by Anne-Marie Faiola Storey Publishing 2016

B. Sc Chemistry Honours/Research 1st Semester

Multi-Disciplinary Courses (MDC)

Course Name	Chemistry Essential for Everyday Life	L	T	P	C
Course Code	MDCBCH-101	2	1	0	3

Chemistry Essential for Everyday Life

Course Objectives: This course provides knowledge and understanding about chemistry essentials for everyday life. Course creates depth knowledge about chemistry of water, food additives, Industrial products, Fertilizers and cosmetics.

Course Outcomes

CO1. To gain knowledge about the role of agro chemicals and quality of water.

CO2. Appreciate the significance of food additives.

CO3. Create awareness about Industrial products.

CO4. To understand the crux of chemistry in the field of cosmetology and its various implications.

CO5. To create awareness regarding fertilizers and manuring.

Unit I. Chemistry of Water

8 Hrs

Water - Sources - impurities in natural water - air in water - Physical properties of water - DO - BOD – COD.

Hardness - Unit of hardness - Total Solids - Disadvantages - Softening of water - Potable water.

Purification of water - Distillation - Deionisation - Reverse Osmosis.

Unit II. Food Additives

9 Hrs

Food Colours - Permitted and Non permitted, Artificial sweeteners - Aspartame, Saccharin and cyclamate.

Preservatives - Natural & synthetic. Flavours-Monosodium glutamate – Stabilising and Suspending Agents - Gelatin, pectin. Toxic effects of Food additives.

Adulterants in milk, ghee, oil, coffee powder, Tea, Asafoetida, chilli powder, pulses and turmeric powder - identification.

Unit III. Industrial Products

8 Hrs

Paints, Varnishes, Lacquers and Adhesives - types - constituents - applications; Ceramics-Glasses.

Plastics, Polythene, PVC, Bakelite, Polyesters, Resins and their applications.

Inks - Types - Printing inks - ingredients - additives - Properties of inks - Basics of LED, LCD.

Unit IV. Cosmetics

8 Hrs

Skin products, Soaps and Shampoos - Creams and Lotions. Lipstick and Hairdye - General formulation and constituents.

Perfume - General formulation, Deodorants and Anti perspirants – Chemical constituents.

Toxicology of cosmetics.

Unit V. Fertilizers

7 Hrs

Fertilizer - Classification - natural manures - organic manures - Chemical fertilizer - biofertilizer.

Effect of excess fertilizing and manurity - agro chemicals.

Insecticides - herbicides - fungicides - rodenticides -nematicides.

S. No	Unit	Books Suggested
1	I	R.Gopalan, S.Sundaram, 1998, Fundamentals of Chemistry, Sultan Chand and Sons, New Delhi. B.K.Sharma, 1995, Industrial Chemistry, Goel Publishing and Co, New Delhi.
2	II	B.N.Chakravarthy, Industrial Chemistry , Oxford and IBH Publishing Co, New Delhi.
3	III	B.K.Sharma, 1995, Industrial Chemistry, Goel Publishing and Co, New Delhi.
4	IV	G.D.Gem Nathew, 2009, Chemistry in everyday life, Vishal Publishing Co, Jalandhar, New Delhi. B.K.Sharma, 1995, Industrial Chemistry, Goel Publishing and Co, New Delhi.
5	V	R.Gopalan, S.Sundaram, 1998, Fundamentals of Chemistry, Sultan Chand and Sons, New Delhi. G.D.Gem Nathew, 2009, Chemistry in everyday life, Vishal Publishing Co, Jalandhar, New Delhi.

Note: Tutorial based on Theory (1 Credit)

B. Sc Chemistry Honours/Research 2nd Semester

Multi-Disciplinary Courses (MDC)

Course Name	Environmental Chemistry: Pollution Control Strategies	L	T	P	C
Course Code	MDCBCH-102	2	1	0	3

Course Objectives: Gain in-depth knowledge on natural processes and resources that sustain life and govern economy. Develop critical thinking for shaping strategies for environmental protection, conservation of biodiversity, environmental equity, and sustainable development. Acquire values and attitudes towards understanding complex environmental- economic social challenges, and active participation in solving current environmental problems and preventing the future ones. Adopt sustainability as a practice in life, society, and industry.

Course outcome:

CO1. Students will gain knowledge about environment and sustainable development

CO2. Students will learn about ecosystem and natural resource, its importance and environmental impacts of human activities on natural resource.

CO3. They will understand about problems of environmental pollution, its impact on human and ecosystem and control measures.

CO4. Students will aware the global environmental issues, policies and International agreements, its impact on human communities, biodiversity, global economy and agriculture.

CO5. Create about the biodiversity conservation of biodiversity and its importance.

Course Content

Unit 1. 8 Hrs

Introduction, components of environment: atmosphere, hydrosphere, lithosphere, and biosphere. Scope and importance; Concept of sustainability and sustainable development.

Unit II. 10 Hrs

Ecosystems: Definition and concept of Ecosystem. Structure of ecosystem (biotic and abiotic components); Functions of Ecosystem: Physical (energy flow), Biological (food chains, food web, ecological succession), and Biogeochemical (nutrient cycling) processes.

Unit III. 14 Hrs

Environmental Pollution: Air, water, soil, thermal, and noise, causes, effects, and controls; Primary and secondary air pollutants; Air and water quality standards. Solid waste management: Control measures for various types of urban, industrial waste, Hazardous waste,

E-waste, etc; Waste segregation and disposal. Pollution case studies: Plastic waste management rules, Bhopal gas tragedy, etc

Unit IV.

14 Hrs

Global Environmental Issues and Policies: Causes of Climate change, Global warming, Ozone layer depletion, and Acid rain; Impacts on human communities, biodiversity, global economy, and agriculture.

International agreements and programmes: Earth Summit, UNFCCC, Montreal and Kyoto protocols, Convention on Biological Diversity (CBD), Ramsar convention. Sustainable Development Goals. Environment legislation in India.

Unit V.

14 Hrs

Biodiversity and Conservation: Definition of Biodiversity; Levels of biological diversity. Biodiversity hotspots; Endemic and endangered species of India; IUCN Red list criteria and categories. Biodiversity conservation strategies: in-situ and ex-situ methods of conservation; National Parks, Wildlife Sanctuaries, and Biosphere reserves. Indian wildlife and biodiversity issues, movements, and projects.

Books Suggested

S. No.	Unit	Books Suggested
1	I	1. Raven, P.H, Hassenzahl, D.M., Hager, M.C, Gift, N.Y., and Berg, L.R. (2015). Environment, 8thEdition. Wiley Publishing, USA. 2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
2	II	1. Odum, E.P., Odum, H.T., and Andrews ,J. (1971). Fundamentals of Ecology. Saunders, Philadelphia, USA. 2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
3	III	1. Brusseau, M.L., Pepper, I.L. and Gerba, C.P. (2019). Environmental and Pollution Science, 3rdEdition. Academic Press, USA. 2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
4	IV	1. Divan, S. and Rosencranz, A. (2002). Environmental Law and Policy in India: Cases, Material & Statutes, 2nd Edition. Oxford University Press, India
5	V	1. Primack, R. B. (2014). Essentials of Conservation Biology, Oxford University Press, USA. 2. Singh, J.S., Singh, S.P., and Gupta, S.R. (2017). Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

Note: Tutorial based on Theory (1 Credit)

Multi-Disciplinary Courses (MDC)

Course Name	Elements and Compounds	L	T	P	C
Course Code	MDCBCH-103	2	1	0	3

Course Objectives:

This course provides a comprehensive introduction to the fundamental principles of elements and compounds, exploring their properties, reactions, and applications. It is designed to offer a deep understanding of both theoretical concepts and practical implications in the study of chemistry.

Course Outcomes:

CO-1 Students will demonstrate a thorough understanding of the basic concepts of elements and compounds, including their definitions, classifications, atomic structures, and the role of the periodic table.

CO-2 Students will analyze the physical and chemical properties of elements, predict and identify different types of chemical reactions, and balance chemical equations.

CO-3 Students will differentiate between organic and inorganic compounds, describe their properties, and understand their reactions.

CO-4 Students will explore and evaluate the real-world applications of elements and compounds in industry and medicine, understand the environmental impacts of chemical processes, and apply principles of green chemistry.

Unit 1: Introduction to Elements and Compounds

- Definition and Classification of Elements and Compounds
- Atomic Structure and Periodic Table
- Chemical Bonds: Ionic, Covalent, and Metallic
- Molecular Geometry and Bonding Theories

Unit 2: Properties and Reactions of Elements

- Physical and Chemical Properties of Elements
- Periodic Trends and Their Applications
- Reaction Types: Synthesis, Decomposition, Single Replacement, Double Replacement
- Balancing Chemical Equations and Stoichiometry

Unit 3: Compounds and Their Reactions

- Types of Compounds: Organic vs. Inorganic
- Properties and Reactions of Organic Compounds
- Coordination Compounds and Complexes
- Synthesis and Characterization of Compounds

Unit 4: Practical Applications and Advanced Topics

- Real-World Applications of Elements and Compounds in Industry and Medicine
- Environmental Impact and Green Chemistry
- Advances in Chemical Research and Technology
- Laboratory Techniques and Safety Procedures

Books suggested

S. No.	Unit	Books Suggested
1	I	1. J. D. Lee, Concise Inorganic Chemistry, Chapman and Hall, 1991 2. Arun Bahl, B. S. Bahl and G. D. Tuli, Essential of Physical Chemistry, S. Chand, 2001. 3. Morrison & Boyd, Fundamentals of Organic Chemistry, Pearson Education, 2011.
2	II	1. J. D. Lee, Concise Inorganic Chemistry, Chapman and Hall, 1991 2. Arun Bahl, B. S. Bahl and G. D. Tuli, Essential of Physical Chemistry, S. Chand, 2001. 3. Morrison & Boyd, Fundamentals of Organic Chemistry, Pearson Education, 2011.
3	III	1. J. D. Lee, Concise Inorganic Chemistry, Chapman and Hall, 1991 2. Arun Bahl, B. S. Bahl and G. D. Tuli, Essential of Physical Chemistry, S. Chand, 2001. 3. Morrison & Boyd, Fundamentals of Organic Chemistry, Pearson Education, 2011.
4	IV	1. J. D. Lee, Concise Inorganic Chemistry, Chapman and Hall, 1991 2. Arun Bahl, B. S. Bahl and G. D. Tuli, Essential of Physical Chemistry, S. Chand, 2001. 3. Morrison & Boyd, Fundamentals of Organic Chemistry, Pearson Education, 2011.

Note: Tutorial based on Theory (1 Credit)

B. Sc Chemistry Honours/Research 1st Semester

Skill Enhancement Courses (SEC)

Course Name	Aromatherapy & Essential oil	L	T	P	C
Course Code	SECBCH-101	2	0	1	3

Aromatherapy & Essential oil

Course Outcomes:

C01. Comprehensive Understanding: Students will gain a thorough understanding of essential oils, including their definition, classification, historical significance, and regulatory standards.

C02. Chemical Proficiency: Students will acquire detailed knowledge of the chemical composition of essential oils, focusing on key components such as terpenes, alcohols, and esters.

C03. Mastery of Extraction Techniques: Students will become proficient in both traditional and modern extraction methods, such as steam distillation, cold pressing, and solvent extraction. They will learn to evaluate the factors that influence the choice of extraction methods, as well as the advantages and limitations of each technique, ensuring the production of high-quality essential oils.

C04. Practical Application Skills Students will develop practical skills in formulating and applying essential oils for various uses, including skincare, beauty products, and home and environmental applications.

Course Content

Unit I. Introduction to Essential Oils

8 Hrs

- Definition and classification of essential oils
- Historical overview of essential oil usage
- Regulatory considerations and quality standards

Unit II. Chemistry of Essential Oils

9Hrs

- Chemical composition of essential oils: terpenes, alcohols, esters, etc.
- Factors influencing the chemical profile of essential oils
- Understanding essential oil constituents and their therapeutic properties

Unit III. Extraction Methods

7 Hrs

- Traditional and modern extraction techniques: steam distillation, cold pressing, solvent extraction, etc.
- Factors influencing the choice of extraction methods

Unit IV. Practical Applications of Essential Oils

6 Hrs

- Skincare and beauty applications: facial serums, body oils, and hair care products
- Home and environmental use: room sprays, natural cleaning products, and insect repellents

Books Suggested

S. No	Unit	Books Suggested
1	I	<p>1. The Complete Book of Essential Oils and Aromatherapy by Valerie Ann Worwood, 2016, New World Library, ISBN: 978-1577311393</p> <p>2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisser and and Rodney Young, Churchill Livingstone, ISBN: 978-0443062414</p> <p>3. Aromatherapy: An A-Z: The Most Comprehensive Guide to Aromatherapy Ever Published by Patricia Davis, 2011, C W Daniel, ISBN: 978-009190661</p>
2	II	<p>1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992</p> <p>2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisser and and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414</p>
3	III	<p>1. Aromatherapy: An A-Z: The Most Comprehensive Guide to Aromatherapy Ever Published by Patricia Davis, 2011, C W Daniel, ISBN: 978-009190661</p> <p>2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisser and and Rodney Young, Churchill Livingstone, ISBN: 978-0443062414</p>
4	IV	<p>1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992</p> <p>Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisser and and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414</p>

Lab.: Aromatherapy & Essential oil

30 Hrs

Experiments Based on Theory Paper

Laboratory shall constitute of the following:

Unit I: Perform different extraction methods of a selected plant material.

Unit II: Perform physico-chemical analysis of essential oils.

Unit III: Compare chemical profiles of oils extracted by different methods.

Unit IV: Create facial creams, soap, body oils, and hair care products using essential oils.

Books Suggested:

S. No	Unit	Books Suggested
1	I	1. The Complete Book of Essential Oils and Aromatherapy by Valerie Ann Worwood, 2016, New World Library, ISBN: 978-1577311393 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, Churchill Livingstone, ISBN: 978-0443062414 3. Aromatherapy: An A-Z: The Most Comprehensive Guide to Aromatherapy Ever Published by Patricia Davis, 2011, C W Daniel, ISBN: 978-009190661
2	II	1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414
3	III	1. Chemistry of Essential Oils Made Simple: God's Love Manifest in Molecules by David Stewart, 2005, Care Publications, ISBN: 978-0934426992 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone, ISBN: 978-0443062414 3. The Chemistry of Essential Oils: An Introduction for Aromatherapists, Beauticians, Retailers, and Students by David G. Williams, 2020, ISBN: 979-8691322235
4	IV	1. The Chemistry of Essential Oils: An Introduction for Aromatherapists, Beauticians, Retailers, and Students by David G. Williams, 2020, ISBN: 979-8691322235 2. Essential Oil Safety: A Guide for Health Care Professionals by Robert Tisserand and Rodney Young, 2013 (2nd Edition), Churchill Livingstone,

		ISBN: 978-0443062414
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3. The Chemistry of Essential Oils: An Introduction for Aromatherapists, Beauticians, Retailers, and Students by David G. Williams, 2020, ISBN: 979-8691322235

B. Sc Chemistry Honours/Research 2nd Semester

Skill Enhancement Courses (SEC)

Course Name	Herbal Drug Formulations	L	T	P	C
Course Code	SEC BCH-102	2	0	1	3

Herbal Drug Formulations

Objective:

The objective of the Herbal Drug Formulations module is to equip students with comprehensive knowledge and practical skills related to the preparation, quality control, and therapeutic applications of herbal medicines. Through theoretical learning and hands-on experience, students will develop a deep understanding of the principles, techniques, and regulatory aspects involved in formulating herbal drugs for healthcare use. There is a growing demand for herbal medicines worldwide due to their perceived effectiveness, natural origin, and minimal side effects compared to synthetic drugs. However, there is a lack of formal education and training programs focused on herbal drug formulations, resulting in a gap in expertise among healthcare professionals and researchers. This module addresses this need by providing students with specialized knowledge and skills in herbal medicine formulation, enabling them to meet the increasing demand for safe, effective, and standardized herbal products.

Course Outcome:

Upon completion of the Herbal Drug Formulations module, students will:

CO1: Demonstrate a thorough understanding of the principles, techniques, and applications of herbal drug formulations in healthcare.

CO2: Identify and evaluate medicinal plants based on their pharmacognostic characteristics, including morphology, chemistry, and therapeutic properties. Apply various extraction methods to obtain bioactive compounds from medicinal plants, considering factors such as solubility, stability, and bioavailability.

CO3: Design and develop herbal drug formulations using appropriate excipients and additives to enhance stability, efficacy, and patient compliance.

CO4: Implement quality control measures and analytical techniques to ensure the identity, purity, and with the knowledge, skills, and confidence to develop and evaluate herbal drug formulations effectively and ethically.

Course Content

Unit I. Introduction to Herbal Medicine

8 Hrs

- Overview of herbal medicine: history, scope, and significance
- Classification of herbal medicines based on plant parts used and extraction methods
- Importance of herbal drug formulations in traditional and modern healthcare systems

Unit II. Pharmacognosy of Medicinal Plants

8 Hrs

- Study of medicinal plant sources: identification, collection, and cultivation
- Extraction methods for obtaining bioactive compounds: maceration, percolation, distillation, etc.
- Phytochemical analysis and characterization of herbal extracts

Unit III.

- Principles of Formulation Development 6 Hrs
- Factors influencing herbal drug formulations: solubility, stability, bioavailability, etc.
- Selection of excipients and additives for enhancing formulation characteristics
- Principles of dosage form design: tablets, capsules, syrups, ointments, etc.

Unit IV. Quality Control and Standardization

8 Hrs

- Importance of quality control in herbal drug manufacturing
- Analytical techniques for assessing the identity, purity, and potency of herbal products
- Standardization methods to ensure batch-to-batch consistency and efficacy
- Innovative approaches to herbal drug delivery: nanotechnology, microencapsulation, liposomes, etc.
- Targeted delivery strategies for enhancing therapeutic efficacy and reducing side effects

Books Suggested

S. No	Unit	Books Suggested
1	I	1. Herbal Medicine Biomolecular and Clinical Aspects, Second Edition, Edited By Iris F. F. Benzie, Sissi Wachtel-Galor ISBN 9781439807132 2. Quality Control and Evaluation of Herbal Drugs: Evaluating Natural Products and Traditional Medicine" by Pulok K. Mukherjee Elsevier Science Publishing 2019
2	II	1. Herbal Formulas: A Practical Guide" by Jill Stansbury Chelsea Green Publishing Co Publication 2018 2. Botanical medicine in clinical practice edited by Ronald R. Watson, Victor

		R. Preedy 2008
3	III	1. Herbal Drug Technology S S Agrawal; M Paridhavi ISBN: 9788173717871 2012 2. Herbal Formulas: A Practical Guide" by Jill Stansbury Chelsea Green Publishing Co Publication 2018
4	IV	1. Herbal Formulas: A Practical Guide" by Jill Stansbury Chelsea Green Publishing Co Publication 2018 2. Herbal Drug Technology S S Agrawal; M Paridhavi ISBN: 9788173717871 2012 3. A Text Book of Quality Control and Standardization of Herbals Sanjay A. Nagdev, Mayur R. Bhurat, Dr.Md. Rageeb Md. Usman An Dr. Parag R.Patil, 2019 Sanjay A. Nagdev, Mayur R. Bhurat, Dr.Md. Rageeb Md. Usman An Dr. Parag R.Patil

Lab:-Herbal Drug Formulations

Experiments based on theory

30Hrs

Unit I: Demonstrate maceration, percolation, and distillation. Perform qualitative and quantitative phytochemical analysis using methods like TLC, HPLC, and GC-MS.

Unit II: Prepare simple herbal formulations (e.g., teas, tinctures, ointments) using extracted compounds. Conduct experiments to test solubility and stability of different herbal extracts.

Unit III: Experiment with different excipients and additives to enhance formulation characteristics (e.g., stability, taste, texture).

Books Suggested

S. No	Unit	Books Suggested
1	I	Herbal Medicine Biomolecular and Clinical Aspects, Second Edition, Edited By Iris F. F. Benzie, Sissi Wachtel-Galor ISBN 9781439807132 Quality Control and Evaluation of Herbal Drugs: Evaluating Natural Products and Traditional Medicine" by Pulok K. Mukherjee Elsevier Science Publishing 2019
2	II	Herbal Formulas: A Practical Guide" by Jill Stansbury Chelsea Green Publishing Co Publication 2018
3	III	Herbal Drug Technology S S Agrawal; M Paridhavi ISBN: 9788173717871 2012 Herbal Formulas: A Practical Guide" by Jill Stansbury Chelsea Green Publishing Co Publication 2018