Sant Gadge Baba Amravati University, Amravati

Semester-wise Course Structure, Course Code and Credit Distribution and Syllabus for

Faculty of Science and Technology

Degree of Bachelor of Science with the Chemistry (Major) and _____ (Minor) Discipline

As per NEP 2020, Affiliated Colleges

Commencement Year: 2024-25

Preamble:

The syllabus of Chemistry for the First year has been redesigned as per National Education Policy 2020 under Choice based Credit System (CBCS) to be implemented from 2024-2025. In CBCS pattern semester system has been adopted for FY, SY, and TY which includes Discipline Specific Core Course (DSC) at F. Y. level, Ability Enhancement Compulsory Course (AEC), Discipline Specific Elective Course (DSE), and Open Elective Course (OE), Skill Enhancement Course (SEC), Indian Knowledge Science (IKS), Vocational Skill course (VSC), etc.

It imbibes the guidelines verbalized by the UGC, UGC LOCF, NEP-2020, and the Government of Maharashtra for all its Undergraduate programmes. The Board of Study in Chemistry of the SGB Amravati University prepared the syllabus for the first year of the undergraduate programme in Chemistry. The new curriculum of B. Sc. (Chemistry) and B. Sc. (Honors with Research) Chemistry offers courses in the areas of Physical Chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, Polymer Chemistry, Industrial Chemistry, Green Chemistry, Nanoscience and Nanotechnology etc. All the courses have defined objectives and learning outcomes, which will help prospective students choose the elective courses to broaden their skills in chemistry and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academia and industry. The courses also offer ample skills to pursue research as career in the field of chemistry and allied areas.

Programme Attributes of a Chemistry Graduate

Attributes of chemistry graduates under the outcome-based teaching-learning framework may encompass the following:

- **Core competency:** The chemistry graduates are expected to know the fundamental concepts of chemistry and applied chemistry. These fundamental concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent, regular, and time-bound revisions.
- **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 documents with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their ideas/findings/concepts to a wider audience.
- **Critical thinking:** Chemistry graduates are expected to know the basics of cognitive biases, mental models, logical fallacies, scientific methodology, and constructing cogent scientific arguments.
- **Psychological skills:** Graduates are expected to possess basic psychological skills required to face the world at large, as well as the skills to deal with individuals and students of various sociocultural, economic and educational levels. Psychological skills may include feedback loops, self-compassion, self-reflection, goal-setting, interpersonal relationships, and emotional management.
- **Problem-solving:** Graduates are expected to be equipped with problem-solving philosophical approaches that are pertinent across the disciplines.
- **Analytical reasoning:** Graduates are expected to acquire formulate cogent arguments and spot logical flaws, inconsistencies, circular reasoning etc.
- **Research skills:** They are expected to be keenly observant about what is going on in the natural surroundings to awaken their curiosity. Graduates are expected to design a scientific experiment through statistical hypothesis testing and other *a priori* reasoning including logical deduction.

- **Teamwork:** Graduates are expected to be team players, with productive cooperations involving members from diverse socio-cultural backgrounds.
- **Digital Literacy:** Graduates are expected to be digitally literate for them to enroll and increase their core competency via e-learning resources such as MOOC and other digital tools for lifelong learning. Graduates should be able to spot data fabrication and fake news by applying rational skepticism and analytical reasoning.
- **Moral and ethical awareness:** Graduates are expected to be responsible citizen of India and be aware of moral and ethical baseline of the country and the world. They are expected to define their core ethical virtues good enough to distinguish what construes as illegal and crime in Indian constitution. Emphasis be given on academic and research ethics, including fair Benefit Sharing, Plagiarism, Scientific Misconduct and so on.
- **Leadership readiness:** Graduates are expected to be familiar with decision making process and basic managerial skills to become a better leader. Skills may include defining objective vision and mission, how to become charismatic inspiring leader and so on.

Qualification Descriptors

The qualification descriptors for a Bachelor's degree in Chemistry may include following:

i. Systematic and fundamental understanding of chemistry as a discipline.
ii. Skill and related developments for acquiring specialization in the subject.
iii. Identifying chemistry related problems, analysis and application of data using appropriate methodologies.
iv. Applying subject knowledge and skill to solve complex problems with defined solutions.
v. Finding opportunity to apply subject-related skill for acquiring jobs and self-employment.
vi. Understanding new frontiers of knowledge in chemistry for professional development.
vii. Applying subject knowledge for solving societal problems related to application of chemistry in day-to-day life.
viii. Applying subject knowledge for sustainable environment friendly green initiatives.
ix. Applying subject knowledge for new research and technology.

(Source: Learning Outcomes based Curriculum Framework (LOCF) for (B.Sc. with Chemistry) Undergraduate Programme 2020 https://www.ugc.gov.in/pdfnews/0614691_LOCF-chemistry.pdf)

Program Outcomes for BSc

POs:

At the time of graduation, Students would be able to

PO1.Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO2.Effective Communication: Speak, read, write, and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media, and technology.

PO3. Social Interaction: Elicit views of others, mediate disagreements, and help reach conclusions in group settings.

PO4. Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.

PO5. Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.

PO6. Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological change.

Program Specific Outcomes for BSc (Chemistry)
PSOs:

Upon completion of the programme successfully, the learners would be able to-

1. Understand the scope, methodology and application of modem chemistry.
2. Apply theoretical and practical concepts of instruments that are commonly used-in thr most of the chemistry field.
3. Plan and conduct scientific experiments and record the results of such experiments.
4. Get acquainted with the safety of chemicals, transfer, and measurements of chemicals, preparation of solutions, and using physical properties to identify compounds and chemical reactions.
5. Describe how chemistry is useful to solve the social, economic, and environmental problems and issues facing our society in energy, medicine, and health

Employability Potential of the Programme:

A degree in Chemistry is an intelligent choice for future employability and earning potential for learners. Degree program with Chemistry offers the necessary knowledge, develop skills and nurture creativity to achieve success in virtually any field that's even distantly related in some way to chemistry. A degree in chemistry is recognized as a symbol of quality and commitment by employers both inside and outside the chemical industries. Chemistry provides jobs in cutting-edge technologies within science and research as well as in many fields of distant relations. Chemistry graduates apply their skills within the areas of environmental sciences, medical fields, scientific equipment sales, science communication, teaching or academic research, a few to mention. Thus, a degree in chemistry widens numerous prospects and opportunities for a wide variety of careers in many different fields like science, research, business and health care, etc. Chemistry inculcates excellent analytical and mathematical skills, which lead to enhanced problem-solving abilities and critical thinking. This improves the likelihoods to secure job in other fields too. Some important skills and abilities honed by chemistry learners include:

- Cutting-edge scientific and numerical skills
- Curiosity to understand and solve
- Attention to collect and analyse details
- Patience and determination
- Research and development skills
- Analytical skills
- Use of ICT enabled techniques
- Written and oral communications skills

The thriving and widely recognized branches of chemistry like Organic, Inorganic, Physical, Analytical, etc. not only expand critical thinking and the ability to understand other scientific and engineering concepts more easily, but also open new horizons to pursue career in different fields. Organic chemistry offers research and development of organic materials, modify and study carbon-based materials to develop a product having a specific purpose for wider use. They also accomplish various scientific studies to identify or find applications for compounds for society. Many industries like pharmaceuticals, agriculture, paints, dyes, and many more prefer to employ organic chemists. Inorganic chemistry has a greater potential in the fields of metallurgy, synthesis of new materials from different elements, bioinorganic, etc. It focusses on solving the fundamental problems associated with structure of atoms, molecules and their properties. Analytical chemists

find their role for toxicology examinations, quality control and assessment, analysis of pharmaceuticals, investigations for forensic analysis, development of equipment, etc. Analytical chemists work for a particular private or government laboratory or organization, and also develop particular specialties like food technology, forensics or toxicology, to name a few. Physical chemistry enhances critical ability and inculcates problem-solving skills among the learners. All industries rely heavily on physical parameters for manufacturing and quality assurance of products. Apart from the technical and specific skills, a chemistry graduate also acquires fundamental professional skills throughout the degree program to pursue careers not directly related to the field. These skills include:

- Effective listening and communication skills
- Presentation and interaction skills
- Data collection, analysis, and reporting skills
- Modern ICT enabled skills
- Aptitude to work proficiently independently or in a team

Future scope for B.Sc. Chemistry graduates:

- Prestigious institutions like IIT, NIT, IISER, IISc, BARC, and TIFR, a few to mention, offer higher studies such as M.Sc. and Ph.D.
- Likewise, foreign Universities also accept chemistry graduates for higher studies.
- Chemistry students can become small or medium scale entrepreneurs (own industry).
- Union and State Public service commissions like UPSC, MPSC, Bank Probationary officers, other competitive examinations, etc. offer a multitude of jobs and positions like Drug Inspector, Lab chemist, forensic analyst, etc. for chemistry graduates.
- Students can take teaching jobs at Kendriya Vidyalaya, Navodaya Vidyalaya, and High Schools after completing B.Ed. or respective eligibility criteria.
- Laboratory technician in various Public Sector Units like ONGC, IOCL, NTPC, BARC, and Private sector industries.
- Students can become Content Developer for IT industries.
- Students can become Quality Control Chemists/ Food Inspector at Food Co-operation of India, Food Safety and Standards etc
- Laboratory technicians to look after sophisticated instruments like NMR, Mass Spectrometer,
- UV-Visible Spectrophotometer, Single crystal machines, XRD, SEM, AAS, TEM, etc. in research laboratory of academic institutions as well as private sector companies.
- Research Scientist/ Operations Manager/ Chemists / Quality Manager / Research Manager at various industries like Pharmaceuticals, Cement, Plastic, Drugs, Paint, Dyes, Agricultural sector, etc.
- Employee at Security Printing and Minting co-operation of India
- Employee at Office of Controller General of Patent Design and Trade work.

Sant Gadge Baba Amravati University, Amravati
FACULTY: Science and Technology
Teaching and Learning Scheme: for the Degree of Bachelor of Science (Chemistry)
(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR: SEMESTER – I

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Wk)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical) / Outdoor / Field	a	Major/ Minor	Theory1	108200	**General Chemistry-1**	2	2	6
			Lab/ Practical-1	108201	Chemistry Lab 1	2	4	
	b	Minor/ Major	Theory1			2	2	6
			Lab/ Practical-1			2	4	
	c	**Generic/ Open Elective**	**Theory1**	**108202**	**Chemistry in Everyday Life**	**2**	**2**	4
			Theory2	**108203**	**Pollution & Remedies**	**2**	**2**	
	d	**VSC**	-	-	-	-	-	4
		SEC	**Lab/ Practical-2**	**108204**	**Lab 2 (Calibration and Standardization Essentials)**	**2**	**4**	
	e	AEC - English	Theory			1	1	6
		AEC – MIL	Theory			1	1	
		IKS- Generic	Theory				2	
		VEC	Theory			2	2	
	f	CC	**Outdoor**			**2**	**4**	**4**
		TOTAL				**22**	**30**	**30**

FIRST YEAR: SEMESTER – II

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Wk)	Vertical Workload (Hrs/Wk)
Classroom Teaching / Lab Work (Practical) / Outdoor / Field	a	Major/ Minor	Theory2	108205	**General Chemistry-2**	2	2	6
			Lab/ Practical-3	108206	Chemistry Lab 3	2	4	
	b	Minor/ Major	Theory2			2	2	6
			Lab/ Practical-2			2	4	
	c	**Generic / Open Elective**	**Theory3**	**108207**	**Food Safety, Adulteration and Detection**	**2**	**2**	4
			Theory4	**108208**	**Entrepreneurship in Chemistry**	**2**	**2**	
	d	**VSC**	**Lab/ Practical -4**	**108209**	Lab 4 (Chemical Laboratory Practices)	**2**	**4**	8
		SEC	**Lab/ Practical -5**	**108210**	**Lab 5** (IT Skills for Chemists)	**2**	**4**	
	e	AEC - English	Theory			1	1	4
		AEC – MIL	Theory			1	1	
		IKS- Generic	Theory			-	-	
		VEC	Theory			2	2	
	f	CC	**Outdoor**			**2**	**4**	**4**
		TOTAL				**22**	**26**	**26**

Course Category: **Major/ Minor (Theory)-1**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	108200	General Chemistry-1	2	30	2 Hrs	30+20=50

Course Objectives:	1. To understand the basics of atomic structure and arrangement of elements in long form of periodic table. 2. To develop critical thinking about chemical properties of metals and non-metals. 3. Students will learn General Organic Chemistry
Course Outcomes:	After successful completion of the course, a student will be able to- 1. Recall the postulates of Bohr's atomic theory. 2. Identify the quantum numbers associated with the describe shapes of atomic orbitals. 3. To write electronic configurations of elements and their classifications accordingly. 4. Explain the screening effect and its relevance to atomic properties. 5. Analyze the variation of periodic properties in periods and groups. 6. Evaluate the electronegativity trends using Pauling's and Mulliken's scales. 7. Differentiate between inductive, electromeric, resonance, and mesomeric effects. 8. Assess the relative strengths of organic acids and bases 9. Describe the structure of benzene and its stability 10. Apply Huckel's rule of aromaticity.

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	***A) Atomic Structure:*** Bohr atomic theory: Postulates and Limitations, quantum numbers, concept of atomic orbital, shapes of s, p and d orbitals, Aufbau principle, Pauli's exclusion principle and Hund's rule of maximum multiplicity. Electronic Configuration of elements. ***B) Long form of Periodic Table:*** Classification of elements as metals, non-metals and metalloids, main group, transition and inner-transition elements. Positions of elements in periodic table on the basis of electronic configuration. Atomic radius and its types, ionic radius, comparison of atomic and ionic radius.	8 Hrs	8 Marks	1. **Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate structure of atom. 2. **Hands-On Models**: use of model to understand electronic configuration of elements and geometry of molecules . 3. **Problem-Solving Sessions**: Organize regular problem-solving sessions to know the properties of elements and their reactivity. 4. Explore virtual labs and simulations to enhance understanding of periodic table 5. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive discussions. 6. Ask students to create concept maps that illustrate the relationships between different
Unit II	***Periodicity in Properties*:** The screening effect, Slater's rule, Effective nuclear charge with some numerical. Variation of atomic radii in periods and groups. Ionization enthalpy: Definition, factors affecting ionization energy and variation in periodic table. Electron gain enthalpy or electron affinity: Definition and variation in periodic table. Electronegativity: Definition, Pauling's, and Mulliken's scales of electronegativity, Variation in periodic table. Electronegativity and partial ionic character in covalent bond.	7 Hrs	7 Marks	
Unit III	A) **Organic Compounds**: Classification, and Nomenclature, Hybridization, shapes of Methane, Ethane, Ethylene and acetylene, Bond lengths, bond angles and bond energies. Hydrogen bonding in organic compounds (with reference to alcohol, phenols, amines, acids) and **c**onsequences. B) **Electronic Displacements**: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength with emphasis on factors affecting pKa values.	8 Hrs	8 Marks	
Unit IV	A) Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity B) Types, shape and relative stabilities of	7 Hrs	7 Marks	

	reaction intermediates (Carbocations, Carbanions, Free radicals, Carbenes and Nitrenes). Organic Reaction and their mechanism: Addition , Elimination and Substitution Reaction C) Structural Isomerism: Definition, classification with examples. Aromaticity- Criteria for Aromaticity, Huckel Rule. Benzenoid and non-benzenoid compounds. Antiaromatic and Non-aromatic compounds. Modern theory of Aromaticity.			concepts. 7. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 8. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 9. **Any other innovative pedagogy as applicable**

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2. Inorganic Chemistry by A.K. De, Wiley East Ltd.
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4. Advanced Inorganic Chemistry, Vol-I, Satya Prakash, Madan, Tuli, Basu.
5. Selected Topics In Inorganic Chemistry: W.U. Malik, G.D. Tuli & R.D. Madan (S. Chand Publications)
6. B.R. Puri, L.R Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal publication, 2016
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10. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
11. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
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13. Chemical Analysis, John Wiley and Sons.
14. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis.
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18. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
19. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), Oxford Universitiy Press.
20. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure and mechanism, Kluwer Academic Publisher, (2000).
21. Organic Chemistry by S.K. Ghosh.
22. Reaction Mechanism in Organic Chemistry by S.M. Mukharjee and S.P. Singh.
23. Stereochemistry and mechanism through solved problems by P.S. Kalsi.
24. Organic Chemistry by TWG Solomons, 8th edition, John Wiley
25. Organic Chemistry by R. K. Bansal
26. Programmed Review of Organic Chemistry: Nomenclature, Olaf Allan Runquist, Burgess Publishing Company, 1965.

Web resources:

1. Basics of Inorganic Chemistry - https://nptel.ac.in/courses/104101121
2. Structure and Bonding: https://javalab.org/en/alkane_compound_en/
3. Introductory Organic Chemistry I- https://nptel.ac.in/courses/104106119

Model Questions:

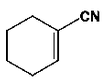
Short Type (At least 8)

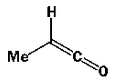
1) Define the terms i) atomic orbital ii) quantum numbers.
2) State i) Aufbau principle ii) Pauli's exclusion principle iii) Hund's rule of maximum multiplicity.
3) Why cation is smaller than corresponding atom?
4) Define i) ionization enthalpy ii) electron gain enthalpy
5) How atomic radius of elements vary in period and group of long form of periodic table?
6) Write two examples of metalloids.
7) Why the elements belonging to the same group do have similar chemical properties?
8) What are the formal charges on the N atom in the CH_3NO_2 molecule?
9) Arrange the following in increasing order of boiling point.
   (i) n-pentane, (ii) isopentane and (iii) neopentane
10) Define Inductive effect with suitable examples.

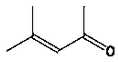
11) Define the term: Chain isomer or Chain Isomerism.
12) Define the terms : Positional isomer or Positional isomerism.
13) Which type of isomerism is shown by the following pair?
CH_3-CH_2-**OH** & CH_3-**O**-CH_3

Long Type (At least 4)

1) Write the postulates of Bohr atomic model.
2) State Pauli's exclusion principle and explain it by taking example of electrons of Helium atom.
3) Explain the variations in the pKa values for the different Hydrocarbons ex. Alkanes, Alkenes & Alkynes.
4) Mention the hybridization state of each carbon atom in these molecules?

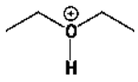


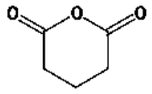


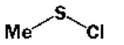


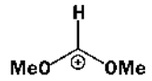
CO_2, $CH_2{=}NCH_3$, CHF_3, $CH_2{=}C{=}CH_2$, $(CH_2)_2O$

5) Each of these molecules is electrophilic. Identify the electrophilic atom and draw a mechanism for reaction with a generalized nucleophile Nu–, giving the product in each case.

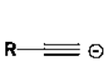


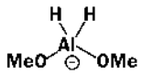


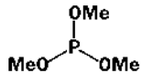


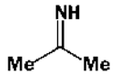


6) Each of these molecules is nucleophilic. Identify the electrophilic atom and draw a mechanism for reaction with a generalized electrophile E+, giving the product in each case









7) What is Inductive effect? Explain –I & +I effects with suitable examples.
8) Explain Electromeric effect with suitable example.
9) Explain the term: Resonance effect with suitable example.
10) Explain the term: Hyperconjugation or No Bond Resonance or Hyperconjugative effect with a suitable example.
11) What are carbocations? How are they obtained? Write their stability order.
12) What is Carbanion ion? Give one preparation of it and explain the structure of carbanion ion.
13) What is/are free radicals? Explain their stability on the basis of resonance effect.
14) Explain Homolytic fission & Heterolytic fission.

MCQs for Internal Assessment (At least 8)

1) No two electrons in the same atoms can have identical set of four quantum numbers". This statement is known as -
A) Pauli's exclusion principle B) Hund's rule
C) Aufbau principle D) Heisenberg uncertainty principle

2) Principal Quantum number describes
A) shape of orbital B)size of the orbital
C) spin of electron D) orientation of in the orbital electron cloud.

3) In modern periodic table, the period number indicates the :
A) atomic number B) atomic mass
C) principal quantum number D) azimuthal quantum number

4) Across period atomic size decreases due to
A) shielding effect B) increase in nuclear force of attraction
C) photoelectric effect D) decrease in nuclear force of attraction

5) Which of the following can exist as diasteromers?
A) Lactic acid B)**2-butene** C) 2-butanol D) propane

6) Which of the following order is correct regarding the -I effect of the substituents?
A) -NR2 > -OR > -F B) -NR2 > -OR < -F
C) -NR2 < -OR < -F D) -NH2 > -OR > -F

7) +I effect (inductive effect) is shown by
(a) -CH_3 (b) -OH (c) -F (d) -C_6H_5

8) Which of the following statements about inductive effect is correct?
(a) It involves electrons in σ-bond (b) The electron pair is only slightly displaced during the +I effect
(c) It is diminishing effect (becoming smaller) **(d) All are correct**

9) In benzyl amine amino group is a
(a) – I group (b) + M group (c) + I group (d) both (a) and (b)

10) Arrange the following in the decreasing order of basic strength
(i) Pyrrole (ii) Pyridine (iii) Aniline
(a) i > ii > iii **(b) ii > iii > i** (c) ii = iii = i (d) iii > ii > i

	11) Which of the following is strongest – I group **(a) – F** (b) – Cl (c) – Br (d) – I 12) Inductive effect refers to – **(a) Electron displacement along a carbon chain through σ-bond** (b) Complete transfer of one of the shared pair of electrons to one of the atoms joined by a double bond (c) Complete transfer of unshared electrons (d) None of the above 13) Which of the following groups has the highest inductive effect? (a) $-CH_3$ (b) CH_3CH_2- (c) $(CH_3)_2CH-$ **(d) $(CH_3)_3C-$** 14) Shifting of electrons of a multiple bond under the influence of a reagent is called_____. (a) I-effect (b) M-effect **(c) E-effect** (d) T-effect 15) Which of the following show electromeric effect? (a) Alkane (b) Alkyl amines (c) Alkyl halides **(d) Aldehydes**

Course Category: **Major Lab-1**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	108201	Chemistry Lab 1	2	60	4 h	25+25= 50

Course Objectives:	Develop practical skills in qualitative analysis of acids and basic radicals, organic compound purification, and accurate determination of physical constants (melting and boiling points) through hands-on laboratory experiments, fostering a comprehensive understanding of key techniques in analytical and organic chemistry.
Course Outcomes:	At the end of this course students will be able to: 1. Identify common acids and basic radicals through qualitative analysis techniques 2. Perform precipitation, gas evolution, and flame tests. 3. Acquire skills in common techniques for the purification of organic compounds. 4. Assess the effectiveness of purification techniques 5. Develop precision in measuring and recording physical constants 6. Analyze the relationship between melting/boiling points and purity. 7. Develop skills in recording and reporting experimental procedures and results.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Introduction to common laboratory glassware and instruments used in practical course 2. SOPs for instruments used in practical course 3. Importance of Calibration with reference to accuracy, precession and minimization of errors	• By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: • Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Flipped Classroom Model:** Encourage students to come to class prepared, promoting active participation. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask questions, and seek clarification. • **Technology Integration:** Incorporate digital tools for data analysis and presentation. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader perspective on chemical lab practices. • **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. • **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge
Inorganic Chemistry practical	***Qualitative analysis of simple salts:*** 1. Semi-micro inorganic qualitative analysis of a sample containing two anions (acidic radicals) of two different groups amongst Group I: CO_3^{2-}, SO_3^{2-}, S^{2-}, NO_2^- Group II: Cl^-, Br^-, I^-, NO_3^- Group III: SO_4^{2-}, PO_4^{3-}. (At least four mixtures of different combinations to be given) ***Probable mixture combination*:** i) Carbonate + chloride/bromide/iodide (no sulphite) ii) Sulphite + chloride/bromide/iodide iii) Sulphide + nitrate/sulphate/phosphate (no chloride/bromide/iodide) iv) Nitrite + chloride/bromide/iodide (no nitrate) v) Nitrate + sulphate/sulphite/phosphate (no bromide/iodide/nitrite) 2. Identification of cations (basic radicals) in simple salts by flame tests. (simple chloride salts to be given to the students containing Na^+, Ba^{++}, Cu^{++}, Pb^{++}, Sr^{++}, Sn^{2+} and Bi^{3+} ions) 3. Identification of cations (basic radicals) in colored salts by borax bead tests. (simple salts to be given to the students containing Cr^{3+}, Fe^{++}or Fe^{3+}, Cu^{++}, Mn^{++}, Co^{++} and Ni^{2+} ions.) 4. Identification of group I basic radicals (Pb^{2+}, Ag^+ or Hg_2^{2+})present in given sample solution by adding dil. HCl as a group reagent followed by treatment with ammonium hydroxide and NaOH or KI or Potassium chromate. (Mixture of Lead nitrate, silver nitrate and mercurous nitrate should be given to the students) **5.** Spot test analysis of some basic radicals in given sample. Following group cations may used for spot test Group IIA: Cu^{2+},(Rubeanic acid test), Cd^{2+}(1,5-diphenyl carbazide test), Bi^{3+} (thiourea test) Group IIB: As^{3+}(Silver nitrate test) Group III: Fe^{3+}(ammonium thiocyanate test)), Group IV: Mn^{2+}, Co^{2+}(ammonium thiocyanate test), Zn^{2+}(Ammonium mercury thiocyanate solution test), Ni^{2+}(DMG test/ Rubeanic acid test) Group V: Ba^{2+},(Potassium chromate test) Special group: Ammonium ion.(Test with dil NaOH) 6. Separation of mixture of Group I and II basic	

	radicals by using dilute HCl and identification of the radicals present in the mixture by spot tests only. (At least two mixtures, each containing one group I and one group II cation, are to be given to the students) Probable mixture combination: i) Lead nitrate + Copper nitrate/sulfate ii) Lead nitrate + Bismuth nitrate iii) Silver nitrate + Copper nitrate/sulfate iv) Silver nitrate + Bismuth nitrate v) Mercurous salt(except chloride) + Copper nitrate/Bismuth nitrate 7. Separation of mixture of Group II and III basic radicals by using ammonium hydroxide and identification of the radicals present in the mixture by spot tests only. (At least two mixtures, each containing one from group II and one from group III cation, are to be given to the students) Probable mixture combination: i) Copper nitrate/sulfate + Ferric chloride/nitrate ii) Bismuth nitrate + Ferric chloride/nitrate iii) Arsenic nitrate + Ferric chloride/nitrate	
Organic Chemistry Practical	*I.* ***Purification Techniques*** **Exercise-** 1. To select suitable solvent from distilled water and rectified spirit for the recrystallization of benzoic acid. 2. To select suitable solvent from distilled water and rectified spirit for the recrystallization of naphthalene. 3. To select suitable solvent from distilled water and rectified spirit for the recrystallization of salicylic acid. 4. Purification of organic compounds by sublimation. 5. Purification of organic liquid by distillation (demonstration). ***II. Determination of Physical Constant- Melting point and boiling point.*** **Exercise-** 1. To determine the melting point of urea. 2. To determine the melting point of benzoic acid 3. To determine the boiling point of ethyl acetate. 4. To determine the boiling point of chlorobenzene. 5. Criteria of purity determination of melting and boiling points. (Any two organic compounds) 6. Effect of impurities on the melting point – mixed melting point of two organic compounds (urea and cinnamic acid or benzoic acid and mandelic acid).	
References	1. Vogel-A text book of qualitative inorganic analysis. 2. Practical Chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpaiand S. Giri (S Chand and company Ltd 3. Kolthoff and Sandell-Text book of qualitative inorganic analysis 4. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press. 5. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson. 6. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press. **Web resources:** 1. https://vlab.amrita.edu/?sub=2 2. https://chemcollective.org/vlabs 3. https://chem.libretexts.org/	
Model Questions:	**NA**	

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 (Inorg. Chem Practical) 10 Marks
- Exercise 2 (Org. Chem Practical) 10 Marks
- Viva-Voce (external) 05 Marks

Total **25 Marks**

Course Category: **GE/OE-1**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	**I**	**108202**	**Chemistry in Everyday Life**	2	30	2 Hrs	30+20 =50

Course Objectives:	The objectives of the course are: 1. Awareness about various nutrients, appropriate personal care products and household products. 3. Awareness basic medicinal chemistry. 4. Reduce use of harmful chemical products.			
Course Outcomes:	By the end of this course, the students will be able to: 1. choose appropriate personal care product for themselves and others. 2. choose proper food products as per their requirements. 3. recognize nature friendly polymers and dyes. 4. assess the benefits and challenges associated with the use of agrochemicals in modern agriculture. 5. realize basics of medications			
Unit System	**Contents**	**Workload Allotted**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Chemistry of Food & Nutrition** a) Understanding the composition of food. b) Digestion and absorption of nutrients c) Energy production from macronutrients d) Functions of vitamins and minerals	8 Hrs	8 Marks	1. **Interactive Lectures:** Combines elements of traditional lectures with interactive activities to engage students. 2.**Project-Based Learning:** Assign project that involves solving a real-world problem. 3. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 4. **Differentiated Instruction:** Tailor instruction to meet individual student needs, considering learning styles, interests, and readiness. 5. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 6. **Role-Playing:** Act out scenarios.
Unit II	**Chemistry of Personal Care Products** a) pH and its importance in the selection of personal care products b) Role of shampoos and conditioners c) Role of cleansers and moisturizers d) Role of sunscreen and anti-aging products	7 Hrs	7 Marks	
Unit III	**Chemistry of Medicine** a) Common diseases and their causes b) Concept of Analgesics, Antibiotics, Antidepressants, Antihypertensives, Antipyretics and Anticoagulants c) Concept of Bronchodilators, Vaccines, Antacids and Diuretics d) Drug Metabolism-Absorption, distribution, metabolism, and excretion (ADME)	8 Hrs	8 Marks	
Unit IV	**Chemistry of Household Products & Agrochemicals** a) Concept of surfactants and their role in cleaning b) Synthetic and natural polymers c) Synthetic and natural dyes d) Benefits and challenges associated with agrochemical use	7 Hrs	7 Marks	
References:	1. Indian Superfoods: Change the Way You Eat by Rujuta Diwekar, Publisher: Juggernaut Books (2016) 2. Food Chemistry by Owen R. Fennema, Publisher: CRC Press (1996) 3. Food Chemistry: Principles and Applications by H.-D. Belitz, Werner Grosch, and Peter Schieberle, Publisher: Springer (2014) 4. Introduction to Food Chemistry, Richard Owusu-Apenten, CRC Press (2014) 5. Chemistry and Technology of Surfactants by Richard J. Farn, Publisher: Blackwell Publishing (2006) 6. The Chemistry and Manufacture of Cosmetics by Maison G. deNavarre, Publisher: Van Nostrand Reinhold (1975) 7. Cosmetic and Toiletry Formulations, Vol. 8 by Ernest W. Flick, Publisher: Noyes Publications/William Andrew Publishing (2000) 8. Medicinal Chemistry: Principles and Practice by Foye, Lemke, Williams, Publisher: Lippincott Williams & Wilkins (2012) 9. Medicinal Chemistry by Graham L. Patrick, Publisher: Oxford University Press (2009) 10. Medicinal Chemistry: The Modern Drug Discovery Process by Erland Stevens, Christopher J. Rhodes, Publisher: Pearson (2017) 11. Handbook for Cleaning/Decontamination of Surfaces by Philippe Cognard, Publisher: William Andrew (2007) 12. Introduction to Polymer Science and Chemistry: A Problem-Solving Approach by Manas Chanda, Publisher: CRC Press (2006)			

	13. Polymer Chemistry by P. M. Visakh and Yoshihiko Arao, Publisher: Springer (2013) 14. Dyes and Dyeing: A Handbook by Charles E. Pellew, Publisher: Asian Educational Services (2000) 15. Introduction to Agrochemicals by P. Pramanik, Publisher: New India Publishing Agency (2007) 16. Agrochemicals and Sustainable Agriculture by R. E. Hoagland, Publisher: American Chemical Society (1993) 17. Agrochemicals: Preparation and Mode of Action by G. Zweig and J. Sherma, Publisher: CRC Press (1990) Web Resources 1. MIT OpenCourseWare 2. TED 3. TEDx Talks
Model Questions:	**Short Type** 1. What are the main macronutrients found in food? 2. Can you explain the difference between saturated and unsaturated fats in food? 3. How do vitamins contribute to the chemical composition of various foods? 4. What are the essential minerals commonly found in food? 5. What are the common chemical components found in sunscreens? 6. What protective measures can be taken to minimize the harmful effects of UV radiation on the skin? 7. What are antacids, and how do they provide relief from acidity and heartburn? 8. What are the emerging trends in medicinal chemistry, particularly in the context of drug discovery? 9. Define synthetic polymers and provide examples of commonly used synthetic polymers. 10. Name some common natural sources of dyes and their colors? 11. What role do agrochemicals play in modern agriculture, and how do they contribute to crop protection? 12. What are surfactants, and how do they contribute to the cleaning process?
	Long Type 1. Write the classification and functions of vitamins and minerals. 2. Explain the effect of UV radiation on human body? 3. Explain drug metabolism in humans. 4. What are agrochemicals? Write its classification. 5. Explain various food preservation methods.
	MCQs 1. What is the primary role of surfactants in cleaning products? a) Emulsification b) Color enhancement c) Odor masking d) Thickening 2. Which chemical reaction is commonly involved in stain removal using cleaning agents? a) Oxidation b) Reduction c) Precipitation d) All of the above 3. What is an example of a synthetic polymer commonly used in everyday products? a) Cellulose b) Rubber c) Polyethylene d) Starch 4. What is the outermost layer of the skin called? a) Dermis b) Epidermis c) Hypodermis d) Subcutis 5. Which skin type benefits most from oil-free cleansers? a) Dry skin b) Oily skin c) Combination skin d) Normal skin 6. Which of the following is a common anti-aging ingredient known for promoting collagen production? a) Hyaluronic acid b) Retinol c) Salicylic acid d) Alpha hydroxy acid 7. Which macronutrient is primarily responsible for providing energy during high-intensity physical activities? a) Proteins b) Carbohydrates c) Fats d) Minerals 8. Which chemical analysis method is commonly used to determine the protein content of food? a) Chromatography b) Spectroscopy

	c) Titration d) Kjeldahl method 9. Antibiotics are primarily used to treat_____. a) Viral infections b) Fungal infections c) Bacterial infections d) Parasitic infections 10. What is a key goal in the development of cancer drugs? a) Increase blood pressure b) Enhance appetite c) Selectively kill cancer cells d) Boost serotonin levels 11. What does ADME stand for in drug metabolism? a) Anticipate, Develop, Monitor, Evaluate b) Absorption, Distribution, Metabolism, Elimination c) Acquire, Digest, Modify, Expel d) Analyze, Document, Manage, Execute 12. Why are ethical considerations important in drug discovery? a) They increase the cost of drug development b) They ensure fair distribution of drugs c) They address safety concerns d) They have no impact on the drug discovery process

Course Category: **GE/OE-2**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	**I**	**108203**	**Pollution & Remedies**	2	30	2 Hrs	30 +20 = 50

Course Objectives:	The objectives of the course are: 1. to aware risks due to pollution. 2. to use appropriate steps to reduce pollution. 3. to aware rules and regulations related to pollution and its control. 4. to gain a holistic understanding of pollution and remedies.			
Course Outcomes:	By the end of this course, the students will be able to: 1. recognize difference between polluted environment and clean environment. 2. prevent nearby society from pollution generating activities. 3. evaluate the environmental, social, and economic impacts of pollution. 4. design a pollution prevention plan for a specific industry or community. 5. develop educational materials to raise awareness about pollution and its remedies. 6. propose innovative solutions for reducing pollution and promoting sustainability.			
Unit System	**Contents**	**Workload Allotted**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	**Idea of Pollution** a) Introduction to pollution, classification of pollutants b) Causes of pollution, harmful effects of pollution c) Sustainable ways of living, rules and regulations to mitigate pollution d) Central Pollution Control Board and its work	8 Hrs	8 Marks	1. **Interactive Lectures:** Combines elements of traditional lectures with interactive activities to engage students. 2.**Project-Based Learning:** Assign project that involves solving a real-world problem. 3. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 4. **Differentiated Instruction:** Tailor instruction to meet individual student needs, considering learning styles, interests, and readiness. 5. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 6. **Role-Playing:** Act out scenarios.
Unit II	**Air Pollution, Water Pollution and Soil Pollution** a) Air Pollution: Causes and effects of air pollution; prevention of air pollution b) Water Pollution: Sources and effects of water pollution c) Soil Pollution: Sources and effects of soil pollution d) Activities: Activities to reduce air pollution, water pollution and soil pollution.	7 Hrs	7 Marks	
Unit III	**Noise Pollution, e-Waste Pollution and Plastic Pollution** a) Noise Pollution: causes and effects of noise pollution; prevention of noise pollution. b) e-Waste Pollution: causes and effects of e-waste pollution; prevention of e-waste pollution. c) Plastic Pollution: causes and effects of plastic pollution; prevention of plastic pollution; microplastics. d) Activities: activities to reduce noise pollution, e-waste pollution and plastic pollution	8 Hrs	8 Marks	
Unit IV	**Light Pollution, Radioactive Pollution and Space Pollution** a) Light Pollution: causes and effects of light pollution; prevention of light pollution. b) Radioactive Pollution: causes and effects of radioactive pollution; prevention of radioactive pollution; nuclear weapons; nuclear power plants; Chernobyl disaster. c) Space Pollution: causes and effects of space pollution; prevention of space pollution. d) Activities: activities to reduce light pollution, radioactive pollution and space pollution	7 Hrs	7 Marks	

References:	1. Breathing Here is Injurious to Your Health: The Human Cost of Air Pollution by Jyoti Pande Lavakare, Publisher: Speaking Tiger (2020) 2. Water Chemistry by Mark M. Benjamin, Publisher: McGraw-Hill Education (2002) 3. Soil Pollution: Origin, Monitoring & Remediation by M. N. V. Prasad, Publisher: Elsevier(2017) 4. The Story of Plastic by Izabella Teixeira, Catherine Clark, Publisher: Melville House (2019) 5. The End of Night: Searching for Natural Darkness in an Age of Artificial Light by Paul Bogard, Publisher: Little, Brown and Company (2013) 6. Radioactive Pollution of the Environment by Alexey V. Yablokov, Publisher: Springer (2009) 7. Debris: A History of the Human Space Age by Lisa Ruth Rand, Publisher: Harvard University Press (2021) 8. Environmental Pollution by N. Manivasakam, Publisher: National Book Trust (1984) 9. Environmental Noise Pollution by P.N. Prasad and T.R. Amarnath, Publisher: Crescent Publishing Corporation (2010) 10. Environmental Chemistry by H. Kaur, Publisher: Pragati Prakashan (2015) 11. Pollution Control Acts, Rules & Notifications Issued Thereunder Published by Central Pollution Control Board (2021) Web resources: 1. https://youtu.be/OQWmaYjyolE 2. https://youtu.be/MQLadfsvfLo 3. https://youtu.be/fephtrPt6wk 4. https://youtu.be/Hnfdq2htoKU 5. https://youtu.be/ODni_Bey154 6. https://youtu.be/GPux33UVG_c 7. https://youtu.be/V_A78zDBwYE 8. https://youtu.be/MEb7nnMLcaA 9. https://youtu.be/w_PWL0oZzOc **10.** MIT OpenCourseWare
Model Questions:	**Short Type** 1. What are the primary sources of air pollution? 2. How can nutrient runoff contribute to water pollution? 3. Identify major sources of soil pollution. 4. Define decibel and its relevance to noise pollution. 5. How can prolonged exposure to loud noises affect human health? 6. Name one astronomical observation affected by light pollution. 7. How does excessive artificial light impact ecosystems? 8. What are microplastics, and how do they contribute to ocean pollution? 9. Name a radioactive element commonly associated with nuclear accidents.
	Long Type 1. Explain the major sources of air pollution and their impact on human health and the environment. 2. Discuss the consequences of water pollution on aquatic ecosystems and human populations. 3. Define soil pollution and describe the common pollutants that degrade soil quality. 4. Examine the concept of noise pollution and its effects on human well-being. 5. Explain the sources of plastic waste, including single-use plastics, microplastics, and improper waste disposal.
	MCQs 1. What is the primary source of anthropogenic (human-caused) air pollution? a. Volcanic eruptions b. Industrial emissions c. Natural wildfires d. Oceanic emissions 2. Which of the following is a common non-point source of water pollution? a. Industrial discharges b. Sewage treatment plants c. Agricultural runoff d. Oil spills 3. Noise pollution is measured in units called: a. Decibels (dB) b. Hertz (Hz) c. Watts (W) d. Newtons (N) 4. What is a significant contributor to soil pollution in urban areas? a. Agricultural runoff b. Pesticides and herbicides c. Industrial waste d. Deforestation 5. What is the main consequence of light pollution on ecosystems? a. Increased biodiversity b. Disruption of sleep patterns in animals c. Improved visibility for nocturnal species d. Enhanced photosynthesis in plants 6. Which type of plastic is most commonly associated with environmental pollution? a. Polyethylene b. Polypropylene

	c. Polystyrene d. Polyvinyl chloride (PVC) 7. The Chernobyl disaster is an example of: a. Noise pollution b. Air pollution c. Water pollution d. Radioactive pollution 8. What is the proper disposal method for electronic waste to prevent pollution? a. Landfill disposal b. Incineration c. Recycling d. Dumping in water bodies 9. Which of the following gases is a major contributor to the greenhouse effect? a. Oxygen (O_2) b. Nitrogen (N_2) c. Carbon dioxide (CO_2) d. Hydrogen (H_2)

Course Category: **Skill Enhancement Course SEC-1**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	108204	Lab- 2 **(**Calibration and Standardization Essentials**)**	2	60	--	50

Course Objectives:	The intended objectives are: 1. To introduce glassware and instruments used in a Chemistry laboratory. 2. To understand the importance of calibration of glassware and instruments in tune with concepts of precision and accuracy. 3. To develop awareness about safety measures for handling chemicals.	
Course Outcomes:	At the end of this course students will be able: 1. To define the importance of calibration and standardization in analytical processes 2. To demonstrate techniques for calibrating various glassware used in laboratories. 3. To implement calibration procedures for diverse instruments to ensure accuracy. 4. Emphasize the importance of maintaining accurate records and documentation 5. To identify common calibration issues and implement troubleshooting techniques. 6. To instill a mindset of continuous improvement in calibration techniques	
Unit System	**Contents**	**Incorporation of Pedagogies**
Tutorial and Discussion	1. Introduction, types of chemical analysis, general analytical method, primary standard and secondary standard substances. 2. Calibration of Laboratory Glassware: Burettes, Pipettes, Volumetric Flask, thermometer etc. 3. Calibration of laboratory instruments: pH meter, conductometer, potentiometer and colorimeter.	By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: • Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Flipped Classroom Model:** Encourage students to come to class prepared, promoting active participation. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask questions, and seek clarification. • **Technology Integration:**
Calibration of Glassware	1. Calibration of Burette 2. Calibration of Pipette 3. Calibration of Standard Measuring Flask 4. Calibration of Thermometer (Demonstration)	
Calibration of instruments	1. Calibration of pH meter 2. Calibration of Conductometer 3. Calibration of Colorimeter 4. Calibration of Potentiometer (Demonstration)	
Standardization of solution	1. Preparation of standard solution of an acid (oxalic acid) by weighing and calculation of concentrations in terms of strength, normality, molarity and molality. 2. Preparation of standard solution of a base (sodium carbonate) by weighing and calculation of concentrations in terms of strength, normality, molarity and molality. 3. Prepare 1 % NaOH solution and find its exact normality using standard oxalic acid solution. 4. Determine molarity and strength of unknown hydrochloric acid with the help of standard 0.05M sodium carbonate solution. 5. Standardization of given NaOH solutions using standard 0.02 N Na_2CO_3 6. Prepare 0.1 N H_2SO_4 solution and find out its exact normality using NaOH as an intermediate solution and 0.1 N Oxalic acid as standard solution.	

References:	1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2006) 2. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Hollers'. Crouch (2009) 3. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education (1999) 4. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher (2004) 5. Principles of Instrumental Analysis, D. A. Skoog, F. James Holler, Stanley R. Crouch (2007) 6. Vogel's Textbook of quantitative chemical analysis, 5th edition (1989), Instrumental method of analysis, B.K. Sharma, Goel publishing house. Miscellaneous methods (2005) **Weblinks:** 1. https://vlab.amrita.edu/?sub=2 2. https://chemcollective.org/vlabs	Incorporate digital tools for data analysis and presentation. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader perspective on chemical lab practices. • **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. • **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge • **Any other innovative pedagogy as applicable**
Model Questions	**3. NA**	

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Internal Assessment

• Active participation in activities	15 Marks
• Continuous Assessment Tests (CAT) (At least three tests) *	20 Marks
• Submission of duly certified practical record	10 Marks
• Internal examiner viva-voce	05 Marks
Total	**50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category**: Major (Theory)-2**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	108205	General Chemistry-2	2	30	2 Hrs	30+20=50

Course Objectives:	Students will learn Periodic trends in Main group elements. Students will learn Fundamentals of Physical chemistry w.r.t. Thermodynamics, Gaseous state,
Course Outcomes:	After successful completion of the course, a student will be able to- 1. Analyze the variation of periodic properties in periods and groups. 2. Compare the properties of groups 13, 14, and 15 elements. 3. Explain the inert pair effect and its consequences. 4. Predict the types and structures of interhalogen compounds. 5. Apply Fajan's rules to predict the nature of polar bonds 6. Discuss the concept of entropy as a measure of disorder and randomness. 7. Solve different numerical of varying difficulty associated with thermodynamics, liquid state and gaseous state. 8. Explain the deviation of real gases from ideal behavior. 9. Apply mathematical relationships to real-world scenarios involving gases and liquids

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	***A] s-Block elements:*** Electronic configuration, ionization potential, oxidation states, reducing properties and metallic properties, reactivity and flame coloration. Diagonal relationship between Li and Mg. ***B] p-Block: Group 13 to 15 elements:*** Comparative study of groups 13, 14 and 15 with respect to atomic and ionic radii, ionization potential, electronegativity, oxidation states and inert pair effect. Diagonal relationship between Be and Al. Allotropes of carbon.	8 Hrs	8 Marks	1. **Interactive Lectures:** Use multimedia presentations, interactive slides, and animations to illustrate complex concepts. 2. **Hands-On Models**: Use digital modeling software for virtual three-dimensional visualization. 3. **Problem-Solving Sessions**: Organize regular problem-solving sessions where students can apply theoretical knowledge to solve stereochemistry and bonding problems. 4. Explore virtual labs and simulations to enhance understanding of molecular structures and reactions. 5. **Flip-Class:** Assign readings or video lectures as homework and use class time for interactive
Unit II	***A] p-Block: Group 16 & 17 elements:*** Comparative study of 16^{th} and 17^{th} group elements with reference to electronic configuration, ionization energy and oxidation states. oxidizing properties of halogens with reference to oxidation potential. Interhalogen compounds: Types and their structure. ***B] Polarisation*** **-** Definition, polarising power, polarizability, effect of polarization on nature of bond. Fajan's rules of polarization and its applications.	7 Hrs	7 Marks	
Unit III	***Thermodynamics:*** First law of Thermodynamics and its limitations, Need of Second law. Carnot's heat engine, derivation of expression for the work done and efficiency of Carnot's engine. Statements of Second law of thermodynamics. Concept of Entropy, Physical significance of Entropy, Derivation of expression for the Entropy change for an ideal gas in terms of pressure, temperature and volume. Entropy change for an ideal gas for isothermal, isoberic and isochoric processes, Entropy of fusion, sublimation, vapourization, transition and its calculations. Entropy change for reversible and irreversible processes. Entropy change as a criteria for spontaneity. Numerical.	8 Hrs	8 Marks	
Unit IV	**Gaseous State:** Postulates of kinetic theory of gases, Maxwell-Boltzmann distribution of velocities (only qualitative treatment), RMS velocity, Average velocity, Most probable velocity, Relationship between	7 Hrs	7 Marks	

	RMS velocity and Average velocity, RMS velocity and Most probable velocity, Mean free path, Collision diameter, Collision number or Collision frequency, Deviation of real gases from ideal behaviour, Explanation of deviations, Derivation of Van der Waal's equation for real gases. Critical phenomenon, Andrew's experiment (isotherms of carbon dioxide). Critical constants. Derivation of relationship between Critical constants (Pc, Tc, Vc) and Van der Waal's constant (a, b). Derivation of reduced equation of state, statement and derivation of Law of corresponding state. Numerical. **Liquid State:** Definition of surface tension, its SI unit and effect of temperature on surface tension, Derivation of expression for relative surface tension by stalagmometer method. Applications of surface tension. Viscosity, definition of coefficient of viscosity, Its SI unit and effect of temperature on viscosity, Derivation of expression for relative viscosity by Ostwald's viscometer method, Applications of viscosity. Numerical.			discussions and problem-solving. 6. Ask students to create concept maps that illustrate the relationships between different concepts in organic chemistry. 7. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 8. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 9. **Any other innovative pedagogy as applicable**
References:	4. Concise Inorganic Chemistry J.D.Lee. Wiley India Edition 5. Inorganic Chemistry by A.K. De, Wiley East Ltd. 6. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry- Principles of 7. Advanced Inorganic Chemistry, Vol-I, Satya Prakash, Madan, Tuli, Basu. 8. Selected Topics In Inorganic Chemistry: W.U. Malik, G.D. Tuli & R.D. Madan (S. Chand Publications) 9. B.R. Puri, L.R Sharma and K.C. Kalia, Principles of Inorganic Chemistry, Vishal publication, 2016 10. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J.(1994),Concepts and Models of Inorganic 11. Chemistry, John Wiley & Sons. 12. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010),Shriver Inorganic Chemistry, 5th Edition, Oxford University Press. 13. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited. 14. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson. 15. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989),Vogel's Textbook of Quantitative 16. Chemical Analysis, John Wiley and Sons. 17. Svehla, G. (1996), Vogel's Qualitative Inorganic Analysis. 18. Physical Chemistry: Walter, J. Moore, 5th edn., New Delhi. 19. Physical Chemistry: G.M. Barrow, McGraw Hill, Indian Edn. 20. Principles of Physical Chemistry: Maron and Prutton. 21. Principles of Physical Chemistry: Puri, Sharma, and Pathania. 22. Physical Chemistry: P.W. Atkins, 6th Edn. 23. Physical Chemistry: Levine 24. A Textbook of Physical Chemistry, Kapoor, K.L. (2019), Vol.7, 1st Edition, McGraw Hill Education **Web resources:** 25. Basics of Inorganic Chemistry - https://nptel.ac.in/courses/104101121 26. Structure and Bonding: https://javalab.org/en/alkane_compound_en/ 27. Introductory Organic Chemistry I- https://nptel.ac.in/courses/104106119			
Model Questions:	**Short Type** 1. Write the sub-shell electronic configuration of i) Magnesium and ii) Potassium 2. What is polarization of bond? 3. What are inter-halogen compounds? 4. Define critical temperature of gas. 5. State law of corresponding state. 6. Define Collision frequency. 7. Define Mean free path. 8. What is critical temperature of carbon dioxide?			

	9. Define surface tension. 10. Define Viscocity. 11. What is the effect of temperature on surface tenstion on liquid? 12. What is the effect of rise in temperature on viscocity of liquid? 13. What is the SI unit of viscocity? 14. Define entropy? 15. State any one statement of second law of thermodynamics. 16. Define Entropy of fusion. 17. what is phase transition? 18. Define entropy of sublimation.
	Long Type 1. Give the diagonal relationship between Li and Mg 2. How polarizing power of cation and polarizability of anion introduce covalent character in ionic bond? Explain. 3. Discuss the oxidizing properties of Halogens. 4. Write the electronic configuration of 16^{th} group elements. 5. Give assumptions of kinetic theory of gases. 6. Explain Maxwell's Boltzmann law for distribution of velocities. 7. Explain Andrew's experiment of liquification of CO_2 gas. 8. Derive relationship between VanderWaal's constants and critical constants. 9. Derive Vander Waal's equation of state. 10. Explain the measurment of surface tention by drop number method. 11. Explain how will you determine relative viscocity of liquid by Ostwald viscometer. 12. Give applications of surfce tension. 13. Give applications of viscocity. 14. The coefficient of viscocity of two liquids at 298 K is 1.408×10^{-3} Kg m^{-1} s^{-1} and 1.594×10^{-3} Kg m^{-1} s^{-1} and their densities are 8.07×10^{2} Kg m^{-3} and 10.17×10^{2} Kg m^{-3} respectively. If the time of flow for the first liquid is 100 seconds, calculate the time of flow for second liquid. 15. Explain need of second law of thermodynamics. 16. Give various statements of second law of thermodynamics. 17. Explain physical significance of entropy. 18. Explain four strokes of carnot heat engine. 19. Show that entropy change for irreversible preocess always takes place with increase in entropy.
	MCQs for Internal Assessment 1) If the valence shell electronic configuration is ns^2np^0, the element will belong to A) alkali metals B) halogens C) alkaline earth metals D) Chalcogens 2) Which of the following element catch fire when exposed to air? A) Helium B) Copper C) Sodium D) Aluminium 3) Which of the following shows most prominent inert pair effect? A) Carbon B) Silicon C) Germanium D) Lead 4) Haber process is used for the preparation of A) Nitrogen B) Hydrogen C) Iron D) Ammonia 5) The geometry of IF_3 molecule is A) trigonal planar B) tetrahedral C) triginal bipyramidal D) octahedral 6) Both of elements of I period contain valence electrons in A) M shell B) N shell C) K shell D) S shell 7) The addition of HBr on 2-butene in presence of peroxide follows (a) Electrophilic addition **(b) Free radical addition** (c) Nucleophilic addition (d) None of these 8) The average distance travelled by molecule between two successive collision is called as … a) Average free path b) Partial free path c) Mean free path d) None of these 9) The condotions required for the ideal gas behavour …. a) Molecules in gaseous state should not attract or repell to each other b) Volume of a gas molecule must be negligible c) Both a and b d) None of these 10) Real gases behaves ideally at…… a) Low temp. and high pressure b) Low temp. and Low pressure c) High temp. and high pressure d) high temp. and low pressure 11) Kinetic theory of gases was proposed by…. a) Boyle's b) Joule c) Bernoulli d) Vander Waal 12) The SI unit of surface tension is….. a) Nm^{-1}

b) Ncm^{-1}
c) $N^{-1}m$
d) None of these

13) The apparatus used to determine surface tension is called as…
a) Ostwald viscometer
b) Thermometer
c) Stalagmometer
d) conductometer

14) The apparatus used to determine viscocity is called as…
a) Ostwald viscometer
b) Thermometer
c) Stalagmometer
d) conductometer

15) The force of attraction between dissimilar molecules is called as…
a) Adhesive
b) Cohesive
c) Magnetic force
d) Gravitational force.

16) The force of attraction between same molecules is called as…
a) Adhesive
b) Cohesive
c) Magnetic force
d) Gravitational force

17) Which thermodynamic process were heat is not exchanged with the surrounding is
a) Isothermal
b) Adiabatic
c) Isobaric
d) Isochoric

18) Which of the following is correct
a) For an isolated system $dS > 0$
b) For a reversible process $dS = 0$
c) For an irreversible process $dS > 0$
d) All of the above

19) Entropy is a measure of
a) Order
b) Disorder
c) Temperature
d) Pressure

20) Efficiency of heat engine is 100% when
a) Temperature of sink is zero
b) Temperature of sink is 100
c) Temperature of source is zero
d) Temperature of source is 100

21) The expression of work done for n mole of gas in reversible isothermal expansion is
a) $w = -2.303nRT \log_{10} V2/V1$
b) $w = -2.303RT \log_{10} V2/V1$
c) $w = -2.303nR \log_{10} V2/V1$
d) $w = -2.303nT\log_{10} V2/V1$

Course Category: **Major Lab-3**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	108206	Chemistry Lab- 3	2	60	--	25+25= 50

Course Objectives:	The intended objectives are: 1. Develop proficiency in fundamental chemical laboratory techniques. 2. Follow established SOPs for various experiments based on physical and Inorganic chemistry. 3. Analyze experimental data and draw meaningful conclusions. 4. Apply critical thinking to troubleshoot and optimize experimental procedures.	
Course Outcomes:	At the end of the Lab/Practical course, students will be able to 1) Skillfully prepare different concentrations of solutions. 2) Determine the strength of commercial samples. 3) Apply volumetric analysis for the estimation of acids and bases in commercial samples. 4) Determine the heat of solution 5) Calculate different thermodynamic parameters 6) Determine surface tension and cleaning ability of detergents and other liquids 7) Determine coefficient of viscosity for different liquids	
Unit System	**Contents**	**Incorporation of Pedagogies**
Inorganic Chemistry Experiments	1. Determine the strength of acetic acid present in commercial vinegar solution (perform at least two exercises by using different sample solutions). 2. Determine the strength of commercial HCl acid sample. 3. Determine the strength of commercial H_2SO_4 acid sample. 4. Estimate the amount of sodium carbonate present in commercial sample. 5. Estimate the amount of sodium bicarbonate present in commercial sample. 6. Prepare 0.1 N standard oxalic acid solution and find out the acid neutralizing capacity (ANC) of an antacid using NaOH as an intermediate solution (perform at least two different samples) 7. Determine the amount of citric acid present in fruit juices (perform at least two exercises by using different sources of fruit juices like orange, lemon, grapefruit, white grape or lime juice, etc.)	By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: • Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Flipped Classroom Model:** Encourage students to come to class prepared, promoting active participation. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask questions, and seek clarification. • **Technology Integration:** Incorporate digital tools for data analysis and presentation. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader perspective on chemical lab practices. • **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. • **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge • **Any other innovative pedagogy as applicable**
Physical Chemistry Experiments	1. Determination of thermodynamic values ($\Delta S°$, $\Delta H°$, and $\Delta G°$) from the dissociation of a weak acid. 2. To determine transition temperature of $MnCl_2.4H_2O$. 3. To determine surface tension of a given unknown liquid by stalagmometer. 4. To determine parachor value of $-CH_2-$ group by stalagmometer. 5. To compare the cleaning power of detergents samples by stalagmometer. 6. To determine coefficient of viscosity of unknown liquid by Ostwald's viscometer. 7. To determine the relative viscosity of given liquid at room temperature by Ostwald's viscometer. 8. To determine heat of solution of KNO_3	

References:	1. Chemistry Lab manual: Pradeep singh and J S Bedi, Evergreen publication Jalandhar. 2. Vogel-A text book of quantitative inorganic analysis. 3. Kolthoff and Stenger- Volumetric analysis-Intersience 4. Kolthoff and Sandell-Text book of qualitative inorganic analysis 5. Vogel-A text book of qualitative inorganic analysis. 6. Practical Chemistry (for B.Sc. I, II and III year students) – O P Pandey, D. N. Bajpaiand S. Giri (S Chand and company Ltd 7. Kolthoff and Sandell-Text book of qualitative inorganic analysis 8. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press. 9. Practicals in physical chemistry a modern approach: P S Sindhu, 1st edition New Delhi. 10. Practical Physical Chemistry: Palit and De. 11. Systematic Experimental Physical Chemsitry: S W Rajbhoj and T K Chondekar, Third Edition, Aurangabad. 12. Advanced Practical Physical Chemistry, J B Yadav, 29Th edition Meerut. 13. Advanced Physical Chemistry Experiments, J N Gurtu and Amit Gurtu, 4th Revised Edition Meerut. 14. Chemistry Lab manual: Pradeep singh and J S Bedi, Evergreen publication Jalandhar. **Web resources:** 1. https://vlab.amrita.edu/?sub=2 2. https://chemcollective.org/vlabs 3. https://chem.libretexts.org/ 4. https://benthambooks.com/book/9781681089102/preface/
Model Questions:	**NA**

Distribution of Marks and the scheme of Practical Examination is as follows:

Section 1: Internal Assessment

- Active participation in activities 10 Marks
- Continuous Assessment Tests (CAT) (At least three tests) * 10 Marks
- Submission of duly certified practical record 05 Marks

Total **25 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Section 2: External Assessment

- Exercise 1 (Inorganic Chem Practical) 10 Marks
- Exercise 2 (Physical Chem Practical) 10 Marks
- Viva-Voce (External) 05 Marks

Total **25 Marks**

Generic /Open Elective- 3

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	**II**	**108207**	**Food Safety, Adulteration, and Detection**	2	30	2 Hrs	30 +20 = 50

Course Objectives:	The objectives of the course are: 1. to make aware about healthy food. 2. to make aware about risk of adulterated food. 3. to aware about detection of adulteration in some food items. 4. to aware about rules and regulations related to adulteration in foods.
Course Outcomes:	By the end of this course, the students will be able to: 1. recognize difference between adulterated and unadulterated food. 2. encourage society to use healthy food. 3. evaluate the economic and health impact of food adulteration. 4. propose innovative solutions for food safety and security. 5. develop educational materials to raise food safety awareness .

Unit System	Contents	Workload Allotted	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	***Introduction to Food Safety*** a) Introduction- Food, Components of food. b) Importance of safe food for public health. c) Key regulatory bodies working for food safety and their roles. d) GMP (Good Manufacturing Practices) and GHP (Good Hygienic Practices)	8 Hrs	8 Marks	1. **Interactive Lectures:** Combines elements of traditional lectures with interactive activities to engage students. 2.**Project-Based Learning:** Assign project that involves solving a real-world problem. 3. **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge. 4. **Differentiated Instruction:** Tailor instruction to meet individual student needs, considering learning styles, interests, and readiness. 5. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. 6. **Role-Playing:** Act out scenarios.
Unit II	**Adulteration in Food** a)Definition and Types of Food Adulteration-Adulteration vs. contamination b)Foodborne Hazards-Microbial contaminants (bacteria, viruses, fungi), Chemical contaminants (pesticides, additives, preservatives), Physical contaminants (foreign objects) c) Causes of adulteration in food d) Consequences of adulteration in food	7 Hrs	7 Marks	
Unit III	**Detection Food Adulteration** a) Detection of- water in milk, detergent in milk b) Detection of other oils in coconut oil c) Detection of- sugar solution in honey, chalk powder in sugar d)Detection of Aluminium leaves in silver leaves e) Detection of- foreign resin in asafetida (hing), papaya seeds in black pepper f)Artificial colour in chilli powder, saw dust in chilli powder g) Detection of chalk in common salt h) Differentiation of common salt and iodized salt	8 Hrs	8 Marks	
Unit IV	**Food Safety Communication and Consumer Awareness** a) Importance of Communication in Food Safety-Communicating risks and preventive measures, Crisis communication in case of food safety issues b) Consumer Education and Empowerment-Promoting awareness about food safety, Understanding food labels and certifications c) Case Studies and Real-life Examples-Analyzing past incidents of food safety issues, Learning from success stories in ensuring food safety d) Future Trends in Food Safety-Discussing upcoming challenges and solutions, Integrating technology and policy for continuous improvement	7 Hrs	7 Marks	

References:	1. Food Safety: The Science of Keeping Food Safe by Ian C. Shaw, Publisher: Wiley (2018) 2. Food Safety Management: A Practical Guide for the Food Industry by Yasmine Motarjemi, Huub Lelieveld, Publisher: Academic Press (2014) 3. Food Safety: A Reference Handbook by Nina E. Redman, Publisher: ABC-CLIO(2018) 4. Food Safety and Standards: Acts, Rules and Regulations by Ashish Kumar Singh, Publisher: Wolters Kluwer (2018) 5. FAO/WHO guidance to governments on the application of HACCP in small and/or less-developed food businesses -FAO FOOD AND NUTRITION PAPER (86) by World Health Organization and Food and Agriculture Organization of the United Nations 6. Detect Adulteration with Rapid Test (DART) Booklet by Food Safety and Standards Authority of India 7. Food Safety: The Science of Keeping Food Safe by Ian C. Shaw, Publisher: Wiley-Blackwell (2019) 8. Food Safety Handbook by Richard L. Linton, L. Jean Dunn, and Gerald J. Cox, Publisher: Wiley (2016) 9. Food Adulteration and Food Fraud by John Spink and PhD Douglas C. Moyer, Publisher: Wiley (2016) 10. Food Adulteration: Incidents, Concerns, and Solutions by P.V. Ramesh and P. Venkatesh, Publisher: CRC Press (2019) 11. Food Fraud Prevention: Introduction, Implementation, and Management by John W. Spink, Publisher: Academic Press (2019) 12. Food Adulteration and Consumer Awareness by Suvendu Bhattacharya, Publisher: Springer (2014) **Web Resources:** 1. www.fssai.gov.in 2. https://youtu.be/eA0gmP4A8Z4 3. https://youtu.be/b6no4afqS6Q 4. https://youtu.be/X9eWJvbQN24 5. https://youtu.be/JEcQv8p708I 6. https://youtu.be/3xLHjXA1Sxw
Model Questions:	**Short Type** 1. What is the primary function of carbohydrates in the human body? 2. Why is safe food important for public health? 3. What is HACCP and why is it important in the food industry? 4. What is food adulteration? 5. What is food contamination? 6. How to detect adulteration of water in milk? 7. How to detect adulteration of artificial color in turmeric? 8. How to differentiate common salt from iodized salt? 9. What is the primary goal of GHP (Good Hygiene Practices)? 10. What is crisis communication in food safety?
	Long Type 1. What is the importance of communication in food safety? 2. What do you understand from food labels? 3. What are the key principles of GMP (Good Manufacturing Practices)? 4. What are the different factors in consumer education for food safety? 5. What are the consequences of food adulteration?
	MCQs 1. What is the primary function of carbohydrates in the body? a. Provide long-term energy storage b. Build and repair tissues c. Regulate body temperature d. Support immune function 2. What does GHP stand for? a. Good Handling Practices b. Good Hydration Practices c. Good Hygiene Practices d. Good Harvesting Practices 3. What does HACCP stand for? a) Hazardous Analysis and Critical Control Points b) Hygiene and Control in Food Production c) Hazard Analysis and Critical Control Points d) High Accuracy in Cooking and Culinary Procedures 4. Which of the following is an example of chemical contaminants? a) Virus b) Bacteria c) Fungi d) Pesticides 5. What is the primary purpose of ensuring food safety? a) To enhance the taste of food b) To prevent food spoilage c) To protect public health d) To increase food production 6. Why is it important to check the expiration date on food products? a) To ensure the food is at the peak of freshness b) To prevent overconsumption c) To reduce food waste d) To avoid consuming expired or spoiled food that may cause illness 7. Generally, papaya seeds are used as adulterant in _____. a) Black pepper b) Chili powder c) Milk d) Hing

	8. Generally, Aluminum leaves are used as adulterant in _____. a) Tea leaves b) Silver leaves c) Coffee powder d) Chili powder 9. Which health organization often advocates for the iodization of salt to address iodine deficiency globally? a) World Health Organization (WHO) b) International Monetary Fund (IMF) c) United Nations Educational, Scientific and Cultural Organization (UNESCO) d) Centers for Disease Control and Prevention (CDC) 10. What is the primary goal of consumer education? a) To increase product prices b) To enhance consumer spending c) To empower consumers to make informed choices d) To promote impulse buying

Generic/ Open Elective – 4

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	**108208**	**Entrepreneurship in Chemistry**	2	30	2 Hrs	30+20 =50

Course Objectives:	The objectives of the course are: 1. to develop an entrepreneurial mindset 2. to identify business opportunities 3. to explore case studies 4. to analyze industry trends			
Course Outcomes:	By the end of this course, the students will be able to: 1. analyze market trends and consumer demands to make informed business decisions. 2. assess the viability and feasibility of a proposed chemical business model. 3. evaluate funding options and choose the most suitable for a given chemical startup. 4. generate innovative ideas for new chemical products or processes. 5. develop a comprehensive business plan for a unique chemical startup.			
Unit System	**Contents**	**Workload Allotted**	**Weightage of Marks Allotted**	**Incorporation of Pedagogies**
Unit I	***Introduction to Entrepreneurship in Chemistry*** a) a) Understanding entrepreneurship in the context of chemistry b) Importance of entrepreneurship in the field of chemistry c) Examining successful entrepreneurial stories in the history of chemistry d) Case Studies-Analyzing case studies of successful chemical entrepreneurs	8 Hrs	8 Marks	1. **Interactive Lectures:** Combines elements of traditional lectures with interactive activities to engage students. 2. **Project-Based Learning:** Assign project that involves solving a real-world problem or creating a product. 3. **Case-Based Learning:** Analyze and discuss real or hypothetical cases to apply theoretical knowledge. 4. **Differentiated Instruction:** Tailor instruction to meet individual student needs, considering learning styles, interests, and readiness. 5. **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research.
Unit II	***Identifying Opportunities in Chemistry*** a) Understanding market trends and demands b) Identifying niche markets and gaps in the chemical sector c) Assessing the role of technology in chemical entrepreneurship d) Identifying opportunities for innovation in chemical processes	7 Hrs	7 Marks	
Unit III	***Planning and Launching a Chemical Venture*** a) Developing a business plan for a chemical venture b) Exploring funding options for chemical startups c) Environmental and safety considerations d) Creating compelling presentations for investors and stakeholders.	8 Hrs	8 Marks	
Unit IV	***Managing and Scaling in the Chemical Entrepreneurship*** a) Efficient management of chemical production processes b) Supply chain optimization and logistics c) Strategies for marketing chemical products d) Building a strong brand identity in the chemical sector	7 Hrs	7 Marks	
References:	1. Entrepreneurship Development in Chemical Science by Kishore R. Chadha, Publisher: PHI Learning Private Ltd, 2009 2. Entrepreneurship in Chemical Engineering by Ravindra Kumar Gupta, Publisher: I.K. International Publishing House Pvt. Ltd., 2007 3. Chemical Engineering Entrepreneurship by S. N. Upadhyay, Publisher: I.K. International Publishing House Pvt. Ltd., 2009 4. Chemical Entrepreneurship by William F. Cooper, Publisher: Oxford University Press, 2013 5. Entrepreneurship in the Chemical and Biotechnology Industries by Shlomo Maital and Sivan Fuchsmann , Publisher: Edward Elgar Publishing, 2007 6. The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail by Clayton M. Christensen, Publisher: Harvard Business Review Press, 1997 7. Starting a Tech Business: A Practical Guide for Anyone Creating or Designing Applications or Software by Alex Cowan, Publisher: Wiley, 2012			

	8. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers by Alexander Osterwalder and Yves Pigneur, Publisher: Wiley, 2010 9. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries, Publisher: Crown Business, 2011 10. Intellectual Property in the New Technological Age by Robert P. Merges and Peter S. Menell, Publisher: Wolters Kluwer, 2019 11. Bioprocess Engineering Principles by Pauline M. Doran, Publisher: Academic Press, 2019 12. The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything by Guy Kawasaki, Publisher: Portfolio, 2015 13. Chemical Engineering in the Pharmaceutical Industry: R&D to Manufacturing by Michael Levin, Publisher: Wiley, 2011 14. MIT OpenCourseWare
Model Questions:	**Short Type** 1. What is the role of entrepreneurship in the field of chemistry? 2. How does an entrepreneurial mindset benefit a chemist? 3. Why is market analysis important in chemical entrepreneurship? 4. What role does intellectual property play in chemical entrepreneurship? 5. Explain the concept of the business model canvas in the context of chemical entrepreneurship. 6. How can chemical entrepreneurs secure funding for their ventures? 7. Why is supply chain management important in chemical entrepreneurship? 8. What challenges do chemical entrepreneurs face in scaling up their ventures? 9. How does branding contribute to the success of a chemical venture? 10. What are some common exit strategies for chemical entrepreneurs?
	Long Type 1: Describe the key challenges faced by entrepreneurs in the chemical industry and discuss strategies to overcome these challenges. 2: Explain the role of intellectual property (IP) in entrepreneurship within the field of chemistry. Provide examples of how entrepreneurs can protect their innovations. 3: Discuss the impact of technological advancements on entrepreneurship in the chemical industry. Provide examples of how technology has driven innovation and business growth in this sector. 4: Explain the scenario of chemical industry in India.
	MCQs for Internal Assessment 1. What does the term "Entrepreneurship" in chemistry refer to? a) Discovering new chemical elements b) Starting and managing chemical businesses c) Conducting research in chemistry laboratories d) Teaching chemistry in academic institutions 2. Which of the following is a key trait of successful chemical entrepreneurs? a) Avoiding all types of risks b) Resisting change and innovation c) Having an entrepreneurial mindset d) Preferring theoretical knowledge over practical experience 3. Why is market analysis crucial in chemical entrepreneurship? a) To memorize market trends b) To identify niche markets and demands c) To avoid competition d) To focus only on local markets 4. What is the role of intellectual property in chemistry entrepreneurship? a) To limit the dissemination of scientific knowledge b) To discourage innovation c) To protect chemical innovations through patents d) To hinder collaboration in the industry 5. What is the purpose of a business model canvas in chemical entrepreneurship? a) To create abstract art related to chemistry b) To visualize and plan the key elements of a business c) To measure chemical reactions in a laboratory d) To design chemical experiments 6. Why is scalability important in the context of chemical entrepreneurship? a) To limit the growth of a chemical venture b) To ensure a small and manageable operation c) To handle increased demand and growth d) To avoid entering global markets 7. What legal and regulatory considerations are important for chemical entrepreneurs? a) Ignoring regulations for faster growth b) Complying with environmental and safety regulations c) Avoiding legal processes for cost reduction d) Focusing only on international regulations 8. What does the term "exit strategy" mean in the context of chemical entrepreneurship? a) A plan to close the business permanently b) A strategy to avoid competition c) A plan to exit a market segment d) A planned way to leave or cash out of a business

	9. In the context of chemical entrepreneurship, what does "Lean Startup" methodology emphasize? a) Focusing on traditional and time-consuming methods b) Efficient use of resources and quick adaptation c) Ignoring customer feedback d) Avoiding innovation and experimentation 10. How can technology and innovation contribute to chemical entrepreneurship? a) By hindering progress and traditional practices b) By making chemical processes more complex c) By providing opportunities for new and improved products and processes d) By isolating chemical entrepreneurs from the technological advancements

Course Category: **Vocational Skill Course VSC-1**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	108209	Lab- 4 (Chemical Laboratory Practices)	2	60	--	50

Course Objectives:	The intended objectives are: 1. Aware the students about the essential safety protocols in a chemical laboratory. 2. Develop proficiency in fundamental chemical laboratory techniques. 3. Follow established SOPs for various chemical experiments.
Course Outcomes:	At the end of this course students will be able: 1. To implement fundamental safety protocols, ensuring a secure working environment in the chemical laboratory. 2. To consistently follow established SOPs for various chemical experiments. 3. To prepare solution of desired concentration.. 4. To maintain accurate and thorough records of experimental data, and analyze results to draw meaningful conclusions. 5. To apply critical thinking skills to identify and address challenges that may arise during experiments, showcasing the ability to troubleshoot and optimize procedures. 6. To gain insights into how chemical lab practices are applied in professional research or industrial settings, preparing them for future careers in diverse scientific and industrial fields. 7. Students will demonstrate ethical conduct in all aspects of laboratory work, emphasizing integrity, responsibility, and professionalism. 8. To gain insights into how chemical lab practices are applied in professional research or industrial settings, preparing them for future careers in diverse scientific and industrial fields.

Unit System	Contents	Incorporation of Pedagogies
Tutorial and Discussion	1. Introduction to common laboratory glassware and instruments used in practical course 2. SOPs for instruments used in practical course 3. Importance of Calibration with reference to accuracy, precession and minimization of errors.	By combining hands-on experiments, discussions, and real-world applications, students will gain a comprehensive understanding of chemistry lab practices. A few suggested pedagogies are: • Students should be given suitable **pre- and post-lab** assignments and explanation revising the theoretical aspects of laboratory experiments prior to and after the conduct of each experiment. • **Hands-On Laboratory Sessions:** Provide regular hands-on laboratory sessions where students can directly apply theoretical knowledge to practical experiments. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Flipped Classroom Model:** Encourage students to come to class prepared, promoting active participation. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask questions, and seek clarification. • **Technology Integration:** Incorporate digital tools for data analysis and presentation. • **Guest Lectures and Industry Connections:** Establish
Lab Safety demonstrations	1. Recognition of Safety symbols, chemical packings and instruments together with the conception of MSDS. 2. Introduction to pictogram of chemical used. (Acids, Bases, Solvents and Salts) 3. Material Safety Data Sheets with reference to hazardous chemicals like $K_2Cr_2O_7$, Benzene, Cadmium nitrate, β-naphthol, CCl_4 and Mercury. 4. Precautions in handling of hazardous substances like conc. acids, ammonia, organic solvents like ether and alcohol. 5. Demonstration of first aid measures for chemical accidents. 6. Demonstration of preventive measures for chemical spills. 7. Demonstration of first aid measures, when chemical materials entered in human body through Eye, Mouth and Skin.	
Solution preparation skills	1. Preparation of 0.1 N solution of oxallic acid and calculate its molarity. 2. Preparation of 0.1 N solutions of sulfuric acid and calculate its molarity. 3. Prepare a stock solution of 1 M NaOH. Prepare 0.5 M, 0.1 M, 0.01 M, and 0.05 M by dilution method using the stock solution. 4. Preparation of 0.1 M and 0.01 M solutions of HCl. 5. Prepare a stock solution of 100 ppm $KMnO_4$. And prepare its 10 ppm and 1 ppm solutions by dilution method. 6. Preparation of 1 or 2% w/v solutions of NaOH/ NaCl, 7. Preparation of 1 or 2% v/v solutions of Acetic acid, HCl, HNO_3, H_2SO_4. 8. Preparation of 0.1 M solutions of ammonia.	

	9. Preparation of a buffer solution of pH= 4. 10. Preparation of a buffer solution of pH= 7. 11. Preparation of a buffer solution of pH= 9.2.	connections with professionals in the field to provide students with a broader perspective on chemical lab practices.
References	1. Instrumental Analysis by Douglas A. Skoog, F. James Holler, Stanley R. Crouch (2006) 2. Fundamental of Analytical Chemistry by Douglas A. Skoog, West, F. James Hollers'. Crouch (2009) 3. Modern Analytical Chemistry by David Harvey, McGraw-Hill Higher Education (1999) 4. S.M. Khopkar, "Basic Concepts of Analytical Chemistry", IInd Edition New Age International Publisher (2004) 5. Principles of Instrumental Analysis, D. A. Skoog, F. James Holler, Stanley R. Crouch (2007) 6. Vogel's Textbook of quantitative chemical analysis, 5th edition (1989), Instrumental method of analysis, B.K. Sharma, Goel publishing house. Miscellaneous methods (2005) **Web resources:** 1. https://vlab.amrita.edu/?sub=2 2. https://chemcollective.org/vlabs	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (VSC) Practical Examination is as follows:

Internal Assessment

• Active participation in activities	15 Marks
• Continuous Assessment Tests (CAT) (At least three tests) *	20 Marks
• Submission of duly certified practical record	10 Marks
• Internal examiner viva-voce	05 Marks
Total	**50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations

Course Category: **Skill Enhancement Course SEC-2**

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	108210	Lab- 5 (IT Skills for Chemists)	2	60	--	50

Course Objectives:	The intended objectives are: 1. Develop proficiency in utilizing IT tools and software relevant to the field of chemistry. 2. Gain hands-on experience in utilizing IT resources for laboratory experiments and simulations in the realm of chemistry. 3. Enhance problem-solving capabilities by integrating IT skills into various aspects of chemical research and analysis. 4. Explore the application of IT in chemical modelling, visualization, and computational chemistry. 5. Cultivate a proactive and adaptive mindset towards emerging technologies in the intersection of IT and chemistry.	
Course Outcomes:	At the end of this course students will be able: 1. To demonstrate utilization of IT tools and software applications relevant to the field of chemistry. 2. To utilize IT resources effectively in laboratory experiments and simulations, enhancing experimental design and data visualization capabilities. 3. To design and perform experiments to use IT techniques for chemistry problems and research. To promote interdisciplinary collaboration through the use of IT tools to enhance communication and cooperation among professionals in chemistry and related fields. 4. To exhibit competence in using IT tools for efficient information retrieval, literature review, and staying updated on the latest developments in the field of chemistry. 5. To develop a proactive and adaptive mindset towards emerging technologies.	
Unit System	**Contents**	**Incorporation of Pedagogies**
Tutorial and Discussion	1. Introduction to IT in Chemistry • Overview of IT tools and software in chemistry • Importance of IT skills in modern chemical research 2. Introduction to Molecular modeling and simulations using IT tools 3. Stoichiometry Tutorials: Making a Standard Solution from Another Solution: Dilution 4. Introduction to the fundamentals and advanced applications of ISIS Draw/ChemSketch/KingDraw/ChemDraw, including drawing chemical structures, reactions and collaborative features, to equip students with essential skills for chemical research and communication.	By combining hands-on training, discussions, and real-world applications, students will acquire comprehensive understanding regarding various IT tools in chemistry. A few suggested pedagogies are: • **Hands-On Workshops:** Conduct workshops where chemists actively use software like ChemDraw, molecular modeling tools, and databases. Allow them to perform tasks such as drawing structures, predicting properties, and retrieving information. • **Demonstrations and Simulations:** Use virtual simulations for certain experiments to enhance accessibility and understanding. • **Problem-Based Learning (PBL):** Foster problem-solving skills by applying IT tools to real-world chemical challenges. • **Flipped Classroom:** Assign pre-class readings or video lectures on IT tools and reserve class time for discussions, problem-solving, and collaborative use of software tools. • **Collaborative Learning:** Assign group projects that require chemists to collectively use IT tools. This promotes knowledge sharing, problem-solving discussions, and a collaborative approach to learning and applying IT skills. • **Interactive Workshops:** Provide opportunities for students to engage in discussions, ask
Experiments on PhET Simulation Tools	1. To investigate factors that affect reaction rates, such as concentration, temperature, and surface area in Chemical Reactions 2. To study how changing temperature, pressure, or volume affects gas properties. 3. To investigate how changing the number and arrangement of atoms influences molecular geometry. 4. To study the impact of temperature and concentration on solubility.	
Experiments on ChemCollective and Amrita Virtual Lab	1. Determine the absolute viscosity of organic liquids. 2. To determine the amount of substance in a solution of unknown concentration using various titrimetric methods. 3. To estimate the amount of barium in the whole of the given solution of barium chloride. 4. Determine the concentration of an unknown HCl solution using NaOH. 5. Determining the solubility of copper chloride at different temperatures. 6. Determine the concentration of unknown silver nitrate solution.	

Experiments on Structure drawing Software such as ChemSketch, ISIS draw, KingDraw, Chemdraw (Windows or Android)	1. Generate structural isomers for a given molecular formula:C_5H_{12}, draw all the possible isomers of pentane. 2. Illustrate the complete curly arrow mechanism of a chemical reaction. Choose a reaction (e.g., nucleophilic substitution, addition reaction) and draw the step-by-step mechanism, including any intermediates and transferring it to MS Word and/or MS PowerPoint (Overall Reaction and its mechanism expected). 3. Draw enantiomers and diastereomers for a given compound. Highlight the stereocenters and demonstrate how the isomers differ. 4. Select a molecule with rotatable bonds and draw its various conformations. Emphasize the most stable conformation and explain the reasons behind its stability. (Drawing 2D- structures of conformations of ethane, butane, and cyclohexane.) 5. Draw a coordination complex with a transition metal center and ligands. Specify the coordination number and geometry of the complex. 6. Drawing 2D- structures of ten heterocyclic compounds and their bi- and tri-substituted derivatives (four derivatives each) 7. Drawing the 2D-structures of at least three marketed drugs and reporting their IUPAC name, usage, and mechanism of action. 8. Conversion of 2D- structures of compounds drawn in Experiment 7 and 8 to their SMILES notations and transferring it to MS Excel spreadsheet in a tabular format. 9. Conversion of 2D- structures of compounds drawn in experiments 7 and 8 to 3D- optimized structures using MMFF94 forcefield and saving as .sdf or .mol file format. 10. Drawing the 2D- structures of five and six membered monosaccharides (Glucose and ribose). 11. Drawing well labelled diagram of simple distillation assembly using ChemSketch.	questions, and seek clarification. • **Technology Integration:** Incorporate digital tools for data analysis and presentation. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader. • **Guest Lectures and Industry Connections:** Establish connections with professionals in the field to provide students with a broader perspective on chemical lab practices. • **Inquiry-Based Learning:** Explore topics through questioning, investigation, and research. • **Case-Based Learning:** Analyze and discuss real cases to apply theoretical knowledge.
Effective use of MS excel	1. Use of excel sheets to develop formulae to calculate normality, molarity, molality, etc. 2. Use of MS Excel to draw scatter plot between molecular weight and number of total atoms, molecular weight and number of carbons atoms, molecular weight and number of hydrogen atoms 3. To create a database of drugs used for a disease using ISIS draw and MS Excel	
References:	**Web resources:** 3. https://vlab.amrita.edu/?sub=2 4. https://chemcollective.org/vlabs 5. https://phet.colorado.edu/ 6. https://chemdrawdirect.perkinelmer.cloud/js/sample/index.html	
Model Questions:	**NA**	

Distribution of Marks and the scheme of (SEC) Practical Examination is as follows:

Internal Assessment

The 50 marks fragmentation as follows:

• Active participation in activities	15 Marks
• Continuous Assessment Tests (CAT) (At least three tests) *	20 Marks
• Submission of duly certified practical record	10 Marks
• Internal examiner viva-voce	05 Marks
Total	**50 Marks**

*Note: Total Performance in CAT (i.e. 40 %) shall be based on the best two out of three in CAT examinations