Nehru Gram Bharati (Deemed to be University)
Prayagraj, Uttar Pradesh, India

B.Sc./ B.Sc. (Honours)/ B.Sc. (Honours with Research)

in Chemistry

[Effective From 2025-26 Onwards]

Four Year Undergraduate Programme
Syllabus
[NHEQF Level 4.5 to 6.0]

(As per NEP-2020 Regulations)

Approved by Board of Studies Date: 29-03-202

Department of Chemistry

Introduction of the Programme:

[a] Introduction:

The NEP-2020 offers an opportunity to affect a paradigm shift from a teacher-centric to a student- centric higher education system in India. It is based on Outcome Based Education, where the Graduate Attributes are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours/Honours with Research) in Botany is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills, as well as to develop Scientific temper, spirit of enquiry, problem solving skills and human and professional values which foster rational and critical thinking in students.

[b] Graduate Attributes:

Type of learning outcomes	**The Learning Outcomes Descriptors**
Learning outcomes that are specific to disciplinary/ interdisciplinary areas of learning	Disciplinary/ interdisciplinary Knowledge & Skills
Generic learning outcomes	***Critical Thinking & problem-solving Capacity***
	Creativity
	Communication Skills: The graduates should be able to demonstrate the skills that enable them to: • listen carefully, read texts and research papers analytically, and present complex information in a clear and concise manner to different groups/audiences, • express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media, • confidently share views and express herself/himself, • construct logical arguments using correct technical language related to a field of learning, work/vocation, or an area of professional practice, • convey ideas, thoughts, and arguments using language that is respectful and sensitive to gender and other minority groups.
	Analytical reasoning/thinking: The graduates should be able to demonstrate the capability to: • evaluate the reliability and relevance of evidence; • identify logical flaws in the arguments of others; • analyze and synthesize data from a variety of sources; • draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints.

	Research-related skills: The graduates should be able to demonstrate: • a keen sense of observation, inquiry, and capability for asking relevant/ appropriate questions, • the ability to problematize, synthesize and articulate issues and design research proposals, • the ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships, • the capacity to develop appropriate methodology and tools of data collection, • the appropriate use of statistical and other analytical tools and techniques, • the ability to plan, execute and report the results of an experiment or investigation, • the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work, regardless of the funding authority or field of study.
	Coordinating/collaborating with others: The graduates should be able to demonstrate the ability to: • work effectively and respectfully with diverse teams, • facilitate cooperative or coordinated effort on the part of a group, • act together as a group or a team in the interests of a common cause and workefficiently as a member of a team.
	Leadership readiness/qualities: The graduates should be able to demonstrate the capability for: • mapping out the tasks of a team or an organization and setting direction. • formulating an inspiring vision and building a team that can help achieve the vision,motivating and inspiring team members to engage with that vision. • using management skills to guide people to the right destination.
	'Learning how to learn' skills: The graduates should be able to demonstrate the ability to: • acquire new knowledge and skills, including 'learning how to learn' skills, that are necessary for pursuing learning activities throughout life, through self-paced and self- directed learning aimed at personal development, meeting economic, social, and cultural objectives, and adapting to changing tradesand demands of the workplace, including adapting to the changes in work processes in the context of the fourth industrial revolution, through knowledge/ skill development/reskilling,
	• work independently, identify appropriate resources required for further learning, • acquire organizational skills and time management to set self-defined goals and targets withtimelines. • inculcate a healthy attitude to be a lifelong learner,
	Digital and technological skills: The graduates should be able to demonstrate the capability to: • use ICT in a variety of learning and work situations, • access, evaluate, and use a variety of relevant information sources, • use appropriate software for analysis of data.
	• ***National & International Perspective considering the current perspective of a Global Village.***

	Value inculcation: The graduates should be able to demonstrate the acquisition of knowledge and attitude that are required to: • embrace and practice constitutional, humanistic, ethical, and moral values in life,including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values, • practice responsible global citizenship required for responding to contemporary global challenges, enabling learners to become aware of and understand global issuesand to become active promoters of more peaceful, tolerant, inclusive, secure, and sustainable societies, • formulate a position/argument about an ethical issue from multiple perspectives • identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification ormisrepresentation of data, or committing plagiarism, and adhering to intellectual property rights, • recognize environmental and sustainability issues, and participate in actions to promote sustainable development.
	Autonomy, responsibility, and accountability: The graduates should be able to demonstratethe ability to: • apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification, • work independently, identify appropriate resources required for a project, and manage a project through to completion,
	Environmental awareness and action: The graduates should be able to demonstrate the acquisition of and ability to apply the knowledge, skills, attitudes, and values required to take appropriate actions for: • mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainabledevelopment and living.
	Community engagement and service: The graduates should be able to demonstrate the capabilityto participate in community-engaged services/ activities for promoting the well-being of society.
	Empathy: The graduates should be able to demonstrate the ability to identify with or understand the perspective, experiences, or points of view of another individual or group, and to identify and understand other people's emotions.

[c] Flexibility:

The programmes are flexible enough to allow liberty to students in designing them according to their requirements. The Learner is given freedom of choice in selecting disciplines. Students may select his/her own stream. He/She may select three major disciplines from his her own stream or two major disciplines from his own stream and one major discipline from any other stream . Alongwith major disciplines, a student can select minor disciplines from other streams, languages, generic electives, ability enhancement courses, Vocational/Skill Enhancement Courses (SEC) and Value added Courses including Extra Curricular activities.

Multiple Entry & Exit Options:

Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme**. + 04 Credit Mandatory Internship in Case of Exit.**	**44**
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme**..** **+ 04 Credit Mandatory Internship in Case of Exit.** For Entry to NHEQF Level 5.0, must have completed the NHEQF 4.5 Level of Four Year Undergraduate Programme as per NEP-2020.	**84**
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme. For Entry to NHEQF Level 5.5, must have completed the NHEQF 5.0 Level of Four Year Undergraduate Programme as per NEP-2020.	**120**
Bachelor Degree with Honours/Honours with Research in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme. For Entry to NHEQF Level 6.0, must have completed the NHEQF 5.5 Level of Four Year Undergraduate Programme as per NEP-2020.	**160**

Programme Educational Objectives (PEOs):

The Undergraduate Curriculum Framework- 2022 (UGCF) is meant to bring about systemic change in the higher education system in the University and align itself with the National Education Policy 2020. The following objectives of NEP are kept in perspective while framing UGCF.

PEO1. To promote each student's holistic development in both academic and non-academic spheres;

PEO2. To provide flexibility to students so that learners have the ability to choose their learning trajectories and programmes, and thereby choose their paths in life according to their talents and interests;

PEO3. To eliminate harmful hierarchies among disciplines/fields of study and silos between different areas of learning; multidisciplinary and holistic education to ensure the unity and integrity of all knowledge;

PEO4. To promote creativity and critical thinking and to encourage logical decision-making and innovation;

PEO5. To promote ethics and human & Constitutional values;

PEO6. To promote multilingualism and the power of language in learning and teaching;

PEO7. To impart life skills such as communication, cooperation, teamwork, and resilience;

PEO8. To promote outstanding research as a corequisite for outstanding education and development.

PRGRAMME OUTCOME (POs)

- The aim of this course is to provide conceptual understanding, development of experimental skills, designing and implementation of novel synthetic methods, developing the aptitude for academic and professional skills, acquiring the basic concepts for structural elucidation with hyphenated techniques, understanding the fundamental chemical and biological processes and rationale towards computer.

- This curriculum would allow students to develop a strong footing in the fundamentals and to specialize in the disciplines of his/her liking and abilities.
- Students will be able to select research domain and present a synopsis of work.
- Students will be able to assess the impact of chemicals on the society as a whole and will be able to create awareness and development for the general community.
- To provide students broad theoretical and applied background in all specialization of chemistry with emphasis on qualitative and quantitative technique.
- To provide broad knowledge of interdisciplinary branches of chemistry involving applied inorganic, organic, physical, nano-technology and biochemistry.

Programme Specific Outcome (PSOs):

The B.Sc.(Hons) programme in Chemistry is designed to develop in students in depth knowledge of the core concepts and principles that are central to the understanding of this core science discipline. Undergraduates pursuing this programme of study go through laboratory work that specifically develops their quantitative and qualitative skills, provides opportunities for critical thinking and team work, and exposes them to techniques useful for applied areas of scientific study.

• **Knowledge: Width and depth:** Students acquire theoretical knowledge and understanding of the fundamental concepts, principles and processes in main branches of chemistry, namely, organic chemistry, inorganic chemistry, physical chemistry, analytical chemistry and biochemistry. In depth understanding is the outcome of transactional effectiveness and treatment of specialized course contents. Width results from the choice of electives that students are offered.

• **Laboratory Skills:** Quantitative, analytical and instrument based: A much valued learning outcome of this programme is the laboratory skills that students develop during the course. Quantitative techniques gained through hands on methods opens choice of joining the industrial laboratory work force early on. The programme also provides ample training in handling basic chemical laboratory instruments and their use in analytical and biochemical determinations. Undergraduates on completion of this programme can cross branches to join analytical, pharmaceutical, material testing and biochemical labs besides standard chemical laboratories.

• **Communication:** Communication is a highly desirable attribute to possess. Opportunities to enhance students' ability to write methodical, logical and precise reports are inherent to the structure of the programme. Techniques that effectively communicate scientific chemical content to large audiences are acquired through oral and poster presentations and regular laboratory report writing.

• **Capacity Enhancement:** Modern day scientific environment requires students to possess abilit y to think independently as well as be able to work productively in groups. This requires some degree of balancing. The chemistry honours programme course is designed to take care of this important aspect of student development through effective teaching learning process.

• **Portable Skills:** Besides communication skills, the programme develops a range of portable or transferable skills in students that they can carry with them to their new work environment after completion of chemistry honours programme. These are problem solving, numeracy and mathematical skills- error analysis, units and conversions, information retrieval skills, IT skills and organizational skills. These are valued across work environments.

Semester -Wise Structure of Syllabus

Department of Chemistry
B.Sc./B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry
SYLLABUS STRUCTURE OVER- All (Based on NEP – 2020)

B.Sc./B.Sc. (Honours)/B.Sc.(Honours with Research) in Chemistry											
Year	**Semester**	**Nomenclature of the Courses/Title**	**Com/Ele.**	**Credit**	Credit Distribution			Teaching Hours			
					L	T	P	L	T	P	
First Year	I	Atomic Structure, Chemical Bonding and Reaction Mechanism	Compulsory	4	2	0	2	30	0	60	
		Introduction to IKS: Chemistry	Compulsory	2	2	0	0	30	0	0	
		Minor Paper for other discipline: Chemistry around us	Pool B	3	3	0	0	45	0	0	
		AEC: Communication Skills & Personality Development	Compulsory	2	2	0	0	30	0	0	
		SEC-1: Paper-I	Pool C	3	1	0	2	15	0	60	
		VAC-1: Understanding India or Pool D	Pool D	2	2	0	0	30	0	0	
		Other Major (compulsory)	Pool A	4	2	0	2	30	0	60	
		Total Semester Credits		**20**							
	II	Stereochemistry, States of Matter and Ionic Equilibrium	Compulsory	5	3	0	2	45	0	60	
		Minor Paper for other discipline: A Map of Elements-Periodic Table	Pool B	3	3	0	0	45	0	0	
		AEC: Critical Thinking & Problem Solving	Compulsory	2	2	0	0	30	0	0	
		SEC-2: Paper-II	Pool C	3	1	0	2	15	0	30	
		VAC-2 : Indian Constitution	Pool D	2	2	0	0	30	0	0	
		Other Major (Contd.)	Compulsory	5	3	0	2	45	0	60	
		Total Semester Credits		**20**							
Exit Option: Certificate in Field of Learning/discipline											
Second	III	Chemical Thermodynamics and its Applications	Compulsory	4	2	0	2	30	0	60	

		Applied IKS-I : Chemistry	Compulsory	2	2	0	0	30	0	0
		Minor Paper for other discipline: Green Chemistry-Sustainable Science	Pool B	3	3	0	0	45	0	0
		AEC: Soft Skills	Compulsory	2	2	0	0	30	0	0
		SEC-3 : Paper-I (Other than Opted in Sem-I)	Pool C	3	1	0	2	15	0	60
		VAC-3 Indian Heritage and Culture/NSS/NCC	Pool D	2	2	0	0	30	0	0
		Other Major (Contd.)	Compulsory	4	2	0	2	30	0	60
		Total Semester Credits		**20**						
	IV	Chemistry of Hydrocarbons	Compulsory	5	3	0	2	45	0	60
		Minor Paper for other discipline: Chemical Biology-Chemistry Meets Life Sciences	Pool B	3	3	0	0	45	0	0
		AEC: Content Writing & Editing	Compulsory	2	2	0	0	30	0	0
		SEC- Paper-II	Pool C	3	1	0	2	15	0	60
		VAC- Food Nutrition & Hygiene	Pool D	2	2	0	0	30	0	0
		Other Major (Contd.)	Compulsory	5	3	0	2	45	0	60
		Total Semester Credits		**20**						
Exit Option : Diploma in Field of Learning/discipline										
Third Year	V	Conductance, Chemical Kinetics, Phase Equilibria and Electrochemical Cells	Compulsory	4	2	0	2	30	0	60
		Applied IKS-II : Chemistry	Compulsory	2	2	0	0	30	0	0
		Minor Papers for Other Discipline: Renewable Energy Resources	Pool B	3	3	0	0	45	0	0
		AEC: Team Building & Leadership	Compulsory	2	2	0	0	30	0	0
		Note: Choose any one Course 1. Industrial Chemicals and Environment 2. Polymer Chemistry 3. Chemistry of Cosmetics and Perfumes	Elective	3	1	0	2	15	0	60
		VAC-5 Environmental Science and Sustainability	Pool D	2	2	0	0	30	0	0
		Other Major (Contd.)	Compulsory	4	2	0	2	30	0	60
		Total Semester Credits		**20**						
	VI	Nitrogen Containing Functional Groups, Polynuclear Hydrocarbons and Heterocyclic Chemistry	Compulsory	5	3	0	2	45	0	60
		Note: Choose any one Paper 1. Instrumental Methods of Chemical Analysis 2. Nanoscale Materials and their Applications 3. IT Skills for Chemists	Core Elective	3	1	0	2	15	0	60
		Minor paper for other Discipline: Drug and API	Pool B	3	3	0	0	45	0	0
		Internship/Apprenticeship (Opted SEC)	Compulsory	4	0	0	4	0	0	120
		Other Major (Contd.)	Compulsory	5	3	0	2	45	0	60
		Total Semester Credits		**20**						

Exit Option : Basic UG degree in Field of Learning/discipline										
Fourth Year	VII	Chemistry of Biomolecules	Compulsory	5	3	0	2	45	0	60
		Research Methodology (Hons. with Research) /Pharmaceutical Chemistry (Honours)	Compulsory	4	4	0	0	60	0	0
		Note: Choose any Two Course (4+4) 1. Basics of Analytical Chemistry 2. Green Methods in Chemistry 3. Chemical Technology & Society	Core Elective	8	4	0	4	60	0	120
		Minor Paper From other discipline **Chemistry in Real World**	Pool Elective	3	3	0	0	45	0	0
		Total Semester Credits		**20**						
	VIII	Spectroscopy	Compulsory	5	3	0	2	45	0	60
		Note: Choose any One: 1. Fuel Chemistry 2. Business Skill for Chemist 3. Food Additives, Contamination and Safety	Core Elective	3	3	0	0	45	0	0
		Dissertation/Research Project & Viva Voce (Hons. with Research) or Field Visit/Tour based Viva Voce (Honours)	Compulsory	12	0	0	12	0	0	360
		Total Semester Credits		**20**						
Completion : UG (Hons./Hons. with Research) degree in Field of Learning/discipline										
		Total Programme Credits		**160**						

Abbreviations:

AEC: Ability Enhancement Course

SEC : Skill Enhancement Course;

VAC: Value Added Course;

IKS: Indian Knowledge System

Department of Chemistry
B.Sc./B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry
SYLLABUS (Based on NEP – 2020)
Session 2025 – 26

YEAR	SEMESTER	PAPER TITLE	Course Code	MAJOR/ MINOR	COM/ EL	(L)	(T)	(P)	TOTAL CREDIT	TEACHING HOURS
1st	I	Atomic Structure, Chemical Bonding and Reaction	CHE-23101	Major	COM	02	00	02	04	90 (30 + 60)
		Introduction to IKS	CHEIKS-2301	Major	COM	02	00	00	02	30
		Minor paper for other Discipline **Chemistry Around Us**	MCHE01	Minor	EL	03	00	00	03	45
	II	Stereochemistry, States of Matter and Ionic Equilibrium	CHE-23102	Major	COM	03	00	02	05	105 (45 + 60)
		Minor paper for other Discipline **A Map of Elements- Periodic Table**	MCHE02	Minor	EL	03	00	00	03	45
2ND	III	Chemical Thermodynamics and its Applications	CHE-23103	Major	COM	02	00	02	04	90 (30 + 60)
		Applied IKS-I : Chemistry	CHEIKS-2302	Major	COM	02	00	00	02	30

		Minor Paper for other discipline **Green Chemistry- Sustainable Science**	MCHE03	Minor	EL	03	00	00	03	45
	IV	Chemistry of Hydrocarbons	CHE-23104	Major	COM	03	00	02	05	105 (45 + 60)
		Minor Paper for other discipline **Chemical Biology- Chemistry Meet Lifesciences**	MCHE04	Minor	EL	03	00	00	03	45
3RD	V	Conductance, Chemical Kinetics, Phase Equilibria and Electrochemical Cells	CHE-23105	Major	COM	02	00	02	04	90 (30 + 60)
		Applied IKS-2 : Chemistry	CHEIKS-2303	Major	COM	02	00	00	02	30
		Minor **Renewable Energy Resources**	MCHE05	Minor	ELE	03	00	00	03	45
		Note: Choose any one Course 1. Industrial Chemicals and Environment 2. Polymer Chemistry 3. Chemistry of Cosmetics and Perfumes	CHE-23106	Core Elective	ELE	03	00	00	03	45

		Nitrogen Containing Functional Groups, Polynuclear Hydrocarbons and Heterocyclic Chemistry	CHE-23107	Major	COM	03	00	02	05	105 (45 + 60)
	VI	Note: Choose any one Course 1. Instrumental Methods of Chemical Analysis 2. Nanoscale Materials and their Applications 3. IT Skills for Chemists	CHE-23108A/ CHE23108B/CHE23108C	Major	ELE	03	00	00	03	45
		Minor Paper for other Discipline: **Drug and API**	MCHE06	Minor	ELE	03	00	00	03	45
		Internship/Apprenticeship	CHE-23109	Major	COM	0	0	04	04	120
IVTH	VIITH	Chemistry of Biomolecules	CHE-23110	Major	COM	03	00	02	05	105 (45+60)
		Research Methodology (Honours with Research)/Pharmaceutical Chemistry (Honours)	CHE-23111A/ CHE-23111B/ CHE-23111C	Major	COM	04	00	00	04	60
		Note: Choose any Two Course (4+4) 1. Basics of Analytical Chemistry 2. Green Methods in Chemistry 3. Chemical Technology & Society	CHE-23112A/ CHE-23112B/ CHE-23112C	Core Elective	ELE	04	00	04	08	180 (60+120)

		Minor Paper for Other Discipline **Chemistry in Real World**	MCHE07	Minor	EL	03	00	00	03	45
	VIII[TH]	Spectroscopy	CHE-23113	Major	COM	03	00	02	05	105 (45 + 60)
		Note: Choose any One Course: 1. Fuel Chemistry 2. Food Additives, Contamination and Safety 3. Business Skill for Chemist	CHE-23114A/ CHE-23114B/ CHE-23114C	Major	ELE	03	00	00	03	45
		Dissertation/Research Project Viva Voce (Hons. with Research) Or Field Visit, Educational Tour based Viva Voce	CHE-23115A/CHE-23115B/ CHE-23115C	Major	COM	00	00	12	12	360

Teaching – learning process:

B.Sc. (Hons) Chemistry programme is designed to provide students with a sound theoretical background and practical training in all aspects of chemistry and helps them develop an appreciation of the importance of chemistry in different contexts. The programme includes foundational as well as in-depth courses that span the traditional sub-disciplines of chemistry. These courses are delivered through classroom, laboratory work, projects, case studies and field work in a challenging, engaging, and inclusive manner that accommodates a variety of learning styles and tools (PowerPoint presentations, audio visual resources, e-resources, seminars, workshops, models, softwares). The laboratory training complements the theoretical principles learned in the classroom and includes synthesis of molecules, measurement of chemical properties and phenomenon, hands-on experience with modern instruments, computational data analysis, modelling and laboratory safety procedures. Different pedagogies such as problem-based learning, peer-led instruction, and technology-aided instruction (blended learning) are adopted wherever suitable. These promote independent thinking, critical thinking and reasoning and a perspective of chemistry as a scientific process of discovery. Students are encouraged to work together in groups which leads to development of interpersonal skills like communication and team work. The student will participate in industrial visits that will lay strong foundation for a successful career as a professional chemist by providing him/her useful information related to the practical aspects of the course and giving an insight to future areas of employment.

Assessment methods:

Assessment methods have two major objectives:

• The primary one is to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base and practical laboratory skills. This is assessed by comprehensive summative end-semester examinations conducted for both theory and practical courses. Also In-course assessments are given in every course in order to assess the students mastery of various learning outcomes. These assessments include individual assignments, group assignments, laboratory notebooks, written reports, quizzes, class tests and periodical tests.

• Another objective is to improve the students' learning and teachers' teaching. Results of assessments and their critical analysis are used to improve the process further by focusing on the areas that need conceptual strengthening, laboratory exposure or design of new experiments.

Core Compulsory Course

SEMESTER-I

B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. First Year**	**Semester: I**
Pedagogy: White board and marker, lecture in Class interaction & discussion and PPT on important topics		
Course Code: CHE-23101	**Course Title: Atomic Structure, Chemical Bonding and Reaction Mechanism**	

Course Objectives: The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic, covalent and metallic bonding and explains that chemical bonding is best regarded as a continuum between the three cases. It discusses the periodicity in properties with reference to the s and p block, which is necessary in understanding their group chemistry.

Course Outcome: After completing this course, the students will be able to -

CO.1 Understand and solve the conceptual questions using knowledge by studying the models of atom, quantum numbers, electronic configuration, shapes of orbitals Schrodinger wave equation and significance of wave function. Understand different types of chemical bonding Gain knowledge on Hybridization, Hyperconjugation, and Inductive effects.

CO.2 Understand the classification of elements, periodicity of atomic properties and general principles of extraction and purification of metals.

CO.3 Draw the plausible structures and geometries of molecules using, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).

CO.4. Explain double salts and coordination compounds, ligands. Isomerism in coordination compounds, stereochemistry ofcomplexes

CO.5 Understand the mechanism of organic & inorganic reactions.

Credits: 2+0+2	**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**

Total Number of Lectures (Lecture + Tutorial + Practical): 30 + 0 + 60

Unit	**Topics**	No. of Lectures
Unit I	**Atomic Structure:** Bohr theory and its limitations, atomic spectrum of hydrogen atom, de-Broglie equation, Heisenberg uncertainty principle, Schrodinger wave equation, Significance of Ψ and Ψ^2, Normalized and orthogonal wave functions. Sign of wave functions. Quantum numbers, shapes of s p d and f orbital, Aufbau's principle and electronic configuration of atoms, Pauli's exclusion principle and Hund's rule of maximum multiplicity.	7
Unit II	**Periodicity of elements (with reference to s- & p-block):** Periodic classification of elements. Atomic, covalent and Ionic radii, Ionization energy, Electron affinity, Electronegativity including trends in periodic table and applications in predicting and explaining the chemical behaviour, Lattice energy and hydration energy. **Extraction of Elements:** General principles of extraction and purification of metals.	05
Unit III	**Chemical Bonding:** Various types of Chemical Bonding: Ionic bond, Covalent bond, Coordinate bond, Sigma bond and pi-bonds, Odd electron bond, Hydrogen bond, Van-der Waals Forces and Metallic bond. Covalent character in ionic bonds, partial ionic character of covalent bond, Hybridization, bond lengths, bond angles, bond energy, localized and delocalized chemical bond, resonance. **Theories of Chemical bond:** Kossel-Lewis Approach, VSEPR theory, Valence bond theory, Molecular orbital theory. **Shapes of molecules:** Shapes of inorganic molecules such as $BeCl_2$, BF_3, NH_3, H_2O, OF_2, Cl_2O, ClO_2, PCl_3,ICl_3, BrF_5, PCl_5, SF_4, ClF_3, IF_7, XeF_2, XeF_4, ClO_4^-.	6

Unit IV	**Coordination Chemistry:** Double salts and coordination compounds, Werner's theory, Sidgwick's concept of effective atomic number (EAN), IUPAC system of nomenclature of coordination compounds. Types and classification of ligands. Isomerism in coordination compounds, stereochemistry ofcomplexes involving coordination number 4 and 6.	4
Unit V	**Inorganic Reaction Mechanism:** Introduction to inorganic reaction mechanisms. Concept of reaction pathways, transition state, intermediate and activated complex. Substitution reactions in square planar complexes, Trans- effect, theories of trans-effect. Thermodynamic and Kinetic stability (using VBT). **Organic reactions Mechanism:** Curved arrow notation, drawing electron movements with arrows, half-headed and double- headed arrows, homolytic and heterolytic bond breaking. Types of reagents electrophiles and nucleophiles, hyperconjugation, aromaticity, inductive field effects. Types of organic reactions, Energy consideration, Reactive intermediates: carbocations, carbanions, free radicals, carbenes, and nitrenes.	8

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010.
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure andReactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Morrison, R. N.; Boyd, R. N. **Organic Chemistry**, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
7. Finar, I. L. **Organic Chemistry** (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)

Suggested online links:

http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have had science stream in class 12th.

Suggested Continuous Evaluation Method:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester, C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assessment will be distributed as under;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals List]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. First year**	**Semester: I**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, engaging students in cooperative learning, learning through practical experience to enhance comprehension.		
Course Code: CHE-23101	**Course Title: Lab work on general safety protocols and handling of equipment.**	
Course Objectives: The course is aimed at introducing students to General Chemistry Laboratory safety measures and exposure them to the basic laboratory operations.		
Course Outcome: After completing this course, the students will be able to -		

CO1. Familiar with the safe working practices in chemistry laboratory.
CO2. Able to handle the apparatus, chemicals and equipment safely.
CO3. Familiar with basic laboratory apparatus/equipment like burette, pipettes, conical flask, weighing bottle etc.
CO4: Able to understand working protocols related to various methods like titration, determination of melting/boiling point, pH determination, etc.

Credit: 0+0+2	**Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	Practicals	No. of Practical (Hrs)
	Part-A **Safety Measures** Design a detailed chart exhibiting Do's and Don't instructions for working in a chemistry laboratory. Prepare the indicative MSDS (Material Safety Data Sheet) of any two chemicals as per Standard MSDS format. Design a chart exhibiting Common Safety Symbols along with its description. Write the common pathways by which Chemicals can enter the body. Write the protocols for safe Disposal of any five Chemicals. Write the guidelines in the Event of a Chemical Accident or Spill. Write the guidelines on Fire Safety in the laboratory.	**60**
	Part-B Calibration and use of apparatus. Preparation of solutions of different Molarity/Normality. To determine the melting point of given solid To determine the boiling point of given liquid. Preparation of standard solutions of acid and base. Estimation of sodium carbonate solution by titration with hydrochloric acid To observe the variation in the pH of acid/base with dilution. To determine the pH of various shampoo and soap solutions.	

Course prerequisite:This course can be opted as an elective by the students of science strem in 12th Class

Suggested Readings:

1. Skoog, D.A.; West, D.M. (2003), Fundamentals of Analytical Chemistry, Brooks/Cole.
2. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis, 6th Edition, Prentice Hall.
3. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
4. Alhuwalia, V.K.; Dhingra, S.; Gulati, A. (2005) College Practical Chemistry, University of Delhi Press.
5. https://edu.rsc.org/resources/practical/experiments
6. Lab Manual

Suggested Continuous Evaluation Method:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: B.Sc. First Year	Semester: I

Pedagogy: White board and marker, lecture, class interaction & discussion

Course Code: CHEIKS-2301	Course Title:	Introduction to Indian Knowledge System

Course Objectives: This course is design to provide knowledge about the foundational Concepts, historical development and evolution of Indian Intellectual traditions and thinkers, and schools of thought within the IKS.

Course Outcomes: After completing this course, the students will be able to -

CO 1: Explain the foundational Concepts & Principles of IKS.
CO 2: Explain the historical development and evolution of Indian Intellectual traditions.
CO 3: Explain the knowledge key texts, thinkers, and schools of thought within the IKS.
CO 4: Analyse the interdisciplinary nature of Indian knowledge, integrating philosophy, spirituality, science, arts, and literature though the study of IKS.
CO 5: Explain the holistic and multidimensional nature of Indian Thought.

Credit: 2+0+0	Paper: Core Compulsory
Max. Marks: 100(40 + 60)	Min. Passing Marks: 35

Total Number of Lectures (Lecture + Tutorials + Practical): 30 + 0 + 0

Units:	Topics	No. of Lectures
I	**Introduction to Indian Knowledge System** • Definition, Concepts and Scope of IKS • IKS based approache on Indian Knowledge System & Role of Guru (teacher) • Understanding the concepts of dharma, karma, and the four purusharthas (goals of life)	06
II	**Vedic Knowledge and Philosophy** • Study of the Vedas, including the Rigveda, Yajurveda, Samaveda, and Atharvaveda • Introduction to Upanishads and their metaphysical and philosophical teachings • Analysis of the six orthodox (astika) schools of Indian philosophy (e.g., Nyaya, Vaisheshika, Yoga, Samkhya, Mimamsa, and Vedanta)	06
III	**Unit 3: Spiritual and Mystical Traditions** • Exploration of Hindu spiritual traditions, including Bhakti, Karma, Jnana, and Raja Yoga • Study of Advaita Vedanta and its nondualistic philosophy • Introduction to other spiritual paths like Tantra and Sufism in the Indian context	06
IV	**Scientific and Technological Advancements** • Examination of ancient Indian contributions to mathematics, astronomy, and medicine • Study of scientific treatises such as Aryabhatiya, Sushruta Samhita, and Charaka Samhita • Exploration of the Indian concept of time, measurement, and cosmology	06

V	**Indian Arts, Literature, and Aesthetics** • Analysis of Indian classical music, dance, and theater traditions • Study of classical Sanskrit literature, including the works of Kalidasa and Valmiki • Understanding the concept of rasa (aesthetic experience) and its manifestations in Indian arts • Modern Interpretation and Contemporary Relevance	06

Suggested Readings:

- "Indian Philosophy: A Very Short Introduction" by Sue Hamilton
- "A History of Indian Philosophy" by Surendranath Dasgupta
- "Indian Philosophy: A Critical Survey" by Chandradhar Sharma
- "India: A History" by John Keay
- "The Wonder That Was India" by A.L. Basham
- "Ancient India" by R.S. Sharma
- "The Oxford History of India" edited by Percival Spear
- "A History of Indian Literature" (multiple volumes) by Sisir Kumar Das
- "Indian English Literature" by M. K. Naik
- "The Norton Anthology of World Literature: India, Pakistan, and Bangladesh" edited by Sarah Lawall
- "Indian Art" by Partha Mitter
- "The Art and Architecture of the Indian Subcontinent" by J.C. Harle
- "Indian Architecture: Buddhist and Hindu Period" by Percy Brown
- "The Crest of the Peacock: Non-European Roots of Mathematics" by George Gheverghese Joseph
- "Indian Science and Technology in the Eighteenth Century" by Dharampal
- "Raga Mala: The Autobiography of Ravi Shankar" by Ravi Shankar
- "The Ragas of North India" by Walter Kaufmann
- "The Complete Book of Ayurvedic Home Remedies" by Vasant Lad
- "Ayurveda: The Science of Self-Healing" by Vasant Lad
- "The Heart of Yoga: Developing a Personal Practice" by T.K.V. Desikachar
- "The Yoga Sutras of Patanjali" translated by Swami Satchidananda

Suggested continuous Evaluation Methods –

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. I First Year**	**Semester: I**
Pedagogy: lectures in classroom, videos, presentation. Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, self-problem solving to enhance comprehension.		
Course Code: MCHE01	**Course Title: *Chemistry around us***	

Course Objectives: The major objective of chemistry is to provide scientific reasoning & analytical problem-solving capability along with application of using conceptual knowledge in practical work. Utilizing the fundamental laboratory techniques and be able to analyse & gain experimental skill. Learn about various processes like Photosynthesis which convert light energy into chemical energy.

Course outcome: After completing this course, the student will be able to -

CO.1 Visualise the importance of Chemistry in daily life.
CO.2 Explain Structure and functions of different classes of chemicals.
CO.3 Explain the process & composition of various chemical substances.
CO.4 Learn to analyse & experimental skills.
CO.5 Describe the process of photosynthesis and rusting.

Credit: 3+0+0	**Paper: Elective**
Max. marks: 100 (40+60)	**Min passing Marks: 35**

Total No. Of Lectures: 45+0+0

Unit	Topics	No. of lectures
Unit I	**Chemistry in everyday life** Atoms, molecules, Acid, bases, PH, polymers, proteins, vitamins, photosynthesis & rusting process etc. Application, use & Importance of chemistry in daily activities. Chemistry of soaps, detergent, cleaning agents, fertilizers, paint, rubber, plastics & chemical waste (solid & liquid). Food chemistry- Preservatives, sweeteners, antioxidants etc. **eg:** *Dairy Products*: Composition of milk and milk products. Analysis of fat content, minerals in milk and butter. Estimation of added water in milk.	10
Unit II	**Chemistry in Medicine & Health** Role of chemistry in drug discovery & development. Structure & function of common drugs (antibiotics, analgesics, antipyretics) – Structure and function of Different Classes/type of Drugs- *Analgesics* – aspirin, paracetamol. *Anthelmentic drug*: mebendazole. *Antiallergic drug*: Chloropheneramine maleate. *Antibiotics*: Pencillin V, Chloromycetin, Streptomycin. *Anti-infalmmatory agent*: Oxypheno-butazone. *Antimalarials*: Primazuine phosphate & Chloroquine, *Neurologically Active Drugs*: Tranquilizers and analgesics, *antidepressant drugs*: Iproniazid and phenelzine Vaccines & their Chemical composition. Biomedical applications – MRI contrast agents / Chemotherapy drugs.	15
Unit- III	**Chemistry in Energy & Technology –** Batteries & Fuel cells Renewable Energy Sources (biofuel, hydrogen, solar, wind, water, geothermal), Nuclear chemistry (Power & medicine), Chemistry in electronics.	8
Unit IV	**Industrial & Material Chemistry** – Polymers & Plastics, chemical industry (petroleum refining, cement, glass, ceramics) Nanotechnology & its applications in *textile*, *electronics*, *medicine*. Green chemistry – biodegradable materials.	5
Unit V	**Environmental Chemistry** – Air pollution, water pollution, soil chemistry & waste mgmt. (recycling & non-biodegradable). *Natural chemical reaction***:** photosynthesis and Rusting.	7

Suggested Readings:

1. Chemistry in Daily Life by Kirpal Singh (Google books).
2. Chemistry in Context: Applying chemistry to society (American Chemical Society).
3. Environmental Chemistry by Colin Baird & Michael Cann (Amazon).
4. Analysis of Foods – H.E. Cox: 13. Chemical Analysis of Foods – H.E.Cox and Pearson.
5. Foods: Facts and Principles. N. Shakuntala Many and S. Swamy, 4th ed. New Age

International (1998) 6. Molecules of Murder: Criminal Molecules & Classic Cases by John Emsley. 7. Chemistry at Home: Exploring the ingredients in everyday products by John Emsley. 8. Environmental Chemistry: A comprehensive approach by Stanley E. Manahan (Wiley).
Suggested continuous Evaluation Methods – Continuous Internal Evaluation shall be of 40% in two Steps in a Semester, C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal Assessment will be distributed as under; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses to Opt:

AEC : Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course (VAC): To be Choosed from POOL D
Other Major : To be Choosed from Pool A

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SEMESTER-II

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. First Year**	**Semester: II**
Pedagogy: Lectures in class rooms, videos, presentations, Teaching Learning Process for the course is visualized as largely student-focused, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE-23102	**Course Title: Stereochemistry, States of Matter and Ionic Equilibrium**	
Course Objectives: To develop basic and advance concepts regarding the Stereochemistry, isomerism and three states of matter. To derive the expressions for determining the physical properties of gases, liquids and solids.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand and solve questions using knowledge by studying stereochemistry and isomerism. **CO.2** Derive mathematical expressions for different properties of gas, liquid and solids and understand their physical significance. **CO.3** Explain and calculate related properties of liquid. **CO.4** Explain the crystal structure and calculate related properties of cubic systems. **CO.5** Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.		
Credits: 3+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorial + Practical): 45+0+60		

Unit	Topics	No. of Lectures
Unit I	**Stereochemistry of organic compounds:** Concept of isomerism. Types of isomerism. Conformational isomerism: Conformational analysis of ethane and n-butane, conformations of cyclohexane, axial and equatorial bonds, conformation of	10

	monosubstituted cyclohexane derivatives. Newman projection and Fischer formulae. Difference between configuration and conformation. **Optical isomerism:** Elements of symmetry, molecular chirality, enantionmers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization. **Geometrical isomerism:** Elementary idea of geometrical isomerism determination of configuration of geometrical isomers. E & Z system of nomenclature, geometrical isomerism in oximes and alicyclic compounds. Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature.	
Unit II	**Gaseous State:** Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation, collision frequency, collision diameter, mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η, variation of viscosity with temperature and pressure. Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. Equation of states for real gases; van der Waals equation of state, its derivation and application in explaining real gas behaviour, Virial coefficients, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.	12
Unit III	**Liquid state:** Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.	6
Unit IV	**Solid state:** Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl.	6
Unit V	**Ionic equilibria:** Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono and diprotic acids. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations.	10

Suggested Readings:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010.
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure andReactivity, Pearson Education 2006.
3. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970.
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
5. Atkins, P.W.; Paula, J.de. (2014) **Atkin's Physical Chemistry Ed**., 10th Edition, Oxford University Press.
6. Ball, D. W. (2017),**Physical Chemistry,** 2nd Edition,Cengage Learning, India.
7. Castellan, G. W. (2004),**Physical Chemistry**, 4th Edition, Narosa.
8. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.

Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have **science stream** in class 12th.

Suggested Continuous Evaluation Method:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practical List]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. First year**	**Semester: II**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE 23102	**Course Title: Lab work based on theory**	
Course Objectives: Experiments are designed in such a way so that students can enjoy learning some of the basic chemistry exercises and Familiar with basic laboratory apparatus/equipment like burette, pipettes, conical flask etc.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Familiar with the safe working practices in chemistry laboratory. **CO2.** Explain the process of identifying radicals of given mixtures. **CO3.** Familiar with basic laboratory apparatus/equipment like burette, pipettes, conical flask, etc. **CO4:** Understand working protocols related to qualitative and quantitative analysis. **CO5:** Explain working ethics in Chemistry lab.		
Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 100(40+60)	**Min. Passing Marks:35**	
Total Number of Practical (Lecture +Tutorial+ Practical): 0 + 0 + 60		

Unit	**Topics**	**No. of Practical (Hrs)**

1.Analysis of inorganic mixture (semi-micro) for four radicals including insoluble radicals and interfering radicals. **2.**Detection of elements and functional groups in organic compounds. **3.**Determination of Iron using $K_2Cr_2O_7$. **4.**Iodometry and Iodimetry (determination of Copper, dichromate and arsenious oxide). **5.**Preparation of buffer solutions of different pH values. (a) Sodium acetate-acetic acid (b) Ammonium chloride-ammonium hydroxide **6.**Surface tension measurements using Stalagmometer: **a.**Determine the surface tension of aqueous solutions by (i) drop number (ii) drop weight method. **b.** Study the variation of surface tension with different concentration of detergent solutions. Determine CMC. **7.**Viscosity measurement using Ostwald's viscometer: **a.** Determination of co-efficient of viscosity of an unknown aqueous solution. **b.** Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar mass of PVA. **c.** Study the variation of viscosity with different concentration of sugar solutions. **8.**Determination of molecular weight of a volatile compound using Victor Meyer's method.	**60**
Suggested Readings: 1. Skoog, D.A.; West, D.M. (2003), Fundamentals of Analytical Chemistry, Brooks/Cole. 2.Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis, 6th Edition, Prentice Hall. 3.Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, Longman Group Ltd. 4.Alhuwalia, V.K.; Dhingra, S.; Gulati, A. (2005) College Practical Chemistry, University of Delhi Press. 5.https://edu.rsc.org/resources/practical/experiments 6. Lab Manual	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

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Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: First Year**	**Semester: II**

Pedagogy: Lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self problem solving to enhance comprehension.

Course Code: MCHE02	**Course Title:** ***Periodic Table - A Map of Elements***

Course Objectives: To provide a foundational understanding of periodic table, its structure and properties of elements. Identify key trends in atomic size, ionization energy, electronegativity, and reactivity. Classify elements based on their properties and predict chemical behaviour. Apply knowledge of the Periodic table to real-world applications and technological advance

Course outcome: After completing this course, the student will be able to -

CO.1 Apply knowledge of the Periodic Table to real-world applications and Understand relationship among elements, metals, gases and why are they placed at particular place & in group including technological advances.
CO.2 Understand the Symbols, atomic numbers, atomic mass and isotopes of elements and nomenclature of elements with atomic number above 100.
CO.3 Classify elements based on their properties, predict chemical behaviour and can describe 3 subatomic particles in an atom & their differences.
CO.4 Understand the physical and chemical Physical Properties of elements.
CO.5 The study of essential and non-essential elements along with Importance & Application of Periodic table.

Credit: 3+0+0	**Paper**: Elective
Max. marks: 100(40+60)	**Min passing Marks**: 35

Total No. Of Lectures: 45+0+0

Unit	Topic	No. of lecture
Unit I	• **The Story of Periodic Table: What is the Periodic Table?** o Historical development (Dmitri Mendeleev and Henry Moseley) o Arrangement of elements by atomic number and chemical properties o Symbols and atomic numbers of elements • **Key Terminologies** o Atomic number, atomic mass, isotopes o Group (Family) and Period (Row)	8
Unit II	**Structure of the Periodic Table** • **Elements and Their Arrangement** o Groups (1-18) – Vertical columns o Periods (1-7) – Horizontal rows • **Categories of Elements** o Metals, Non-metals, Metalloids o Alkali metals, Alkaline earth metals, Halogens, Noble gases o Transition metals, Inner transition metals (Lanthanides and Actinides)	8

Unit-III	**Trends in the Periodic Table and Properties of Elements** • Atomic Radius • Ionization Energy • Electron Affinity • Electronegativity	8
Unit IV	**Properties of Elements** • **Physical Properties** o State (solid, liquid, gas), color, density, etc. o Metallic vs Non-metallic properties • **Chemical Properties** o Reactivity with water, oxygen, acids, bases o Oxidation states, valency	10
Unit V	**Application of the Periodic Table** • **Uses of Elements** o Industrial, medical, and technological applications • **Development of New Materials** o Superconductors, alloys, and new compounds	11
Suggested Readings: 1. Royal Society of Chemistry's Interactive periodic table (periodic-table.rsc.org). 2. PubChem Periodic Table (PubChem). 3. IUPAC Periodic Table of Elements (PubChem). 4. Chemistry Open – Open Access Journal (Chemistry Europe) 5. ACS Omega – Open access Journal (acsopenscience.org) 6. The Periodic Table: A Visual Guide to the Elements by Tom Jackson.		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

Other Courses:

AEC : Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course (VAC): To be Choosed from POOL D

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EXIT OPTION: Undergraduate Certificate (in the field of learning/discipline) for those who exit after the first year (two semesters) of the undergraduate programme.
(Programme duration: first year or two semesters of the undergraduate programme + Mandatory Internship)

[NHEQF 4.5]

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SEMESTER-III

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Second Year**	**Semester: III**
Pedagogy: Lectures in class rooms,videos, presentations, Teaching Learning Process for the course is visualized as largely student-focused, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE 23103	**Course Title: Chemical Thermodynamics and its Applications**	
Course Objectives: The aim of this course is to make students understand thermodynamic concepts, terminology, properties of thermodynamic systems, laws of thermodynamics and their correlation with other branches of physical chemistry and make them able to apply thermodynamic concepts to the system of variable compositions, equilibrium and colligative properties.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties. **CO.2** Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for ideal gases under different conditions. **CO.3** Explain unattainability of absolute zero. **CO.4** Explain the concept of partial molar properties. **CO.5** Explain the thermodynamic basis of colligative properties and applications in surroundings.		
Credits: 2+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**	
Total Number of Lectures (Lecture + Tutorial + Practical): 30+0+60		

Unit	**Topics**	**No. of Lectures**
Unit I	**Chemical Thermodynamics:** Thermodynamics terms, concept of heat Q, work, internal energy, statement of the first law, thermodynamic reversibility, maximum work, enthalpy of a system, heat capacity at constant volume and at constant pressure. Extensive and intensive properties, state functions and exact differentials, cyclic rule. Variation of internal energy with temperature and volume, enthalpy as a function of temperature and pressure. Relation between Cp and Cv, Joule Thompson porous plug experiment, nature of Joule Thompson coefficients, calculation of Q, W, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. **Thermochemistry:** Enthalpy of reactions: standard states, enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.	9
Unit II	**Second Law:** Concept of entropy, statements of the second law of thermodynamics, Carnot cycle, entropy change for reversible and irreversible processes (for ideal gases). Free energy functions: Gibbs (G) and Helmholtz function (A), variation of S, G and A with P,V and T, Free energy change and spontaneity (for ideal gas),	5
Unit III	**Third Law:** Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.	4

Unit IV	**Systems of Variable Composition:** Partial molar quantities, dependence of thermodynamic parameters on composition, Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases. **Chemical Equilibrium:** Criteria of thermodynamic equilibrium, degree of advancement of reaction, Chemical equilibria in ideal gases, Thermodynamic derivation of relation between Gibbs free energy of a reaction and reaction quotient, Equilibrium constants and their dependence on temperature, pressure and concentration, Le Chatelier's Principle (Quantitative treatment), Free energy of mixing and spontaneity, Equilibrium between ideal gases and a pure condensed phase.	6
Unit V	**Solutions and Colligative Properties:** Dilute solutions, lowering of vapour pressure, Raoult's law, Henry's law. Thermodynamic basis of the colligative properties - lowering of vapour pressure, elevation of Boiling Point, Depression of Freezing point and Osmotic pressure and derivation of expressions for these using chemical potential. Application of colligative properties in calculating molar masses of normal, dissociated and associated solutes in solutions. Concept of activity and activity coefficients.	6

Suggested Readings:

1. Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004),Physical Chemistry, 4th Edition, Narosa.
3. Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L.(2015),A Textbook of Physical Chemistry,Vol 2, 6th Edition, McGraw Hill Education.
5. Kapoor, K.L.(2013),A Textbook of Physical Chemistry,Vol 3, 3rd Edition, McGraw Hill Education.
6. McQuarrie, D. A.; Simon, J. D. (2004),Molecular Thermodynamics, Viva Books Pvt. Ltd. .
7. Atkins, P.W.; Paula, J.de. (2014),**Atkin's Physical Chemistry Ed**., 10th Edition, Oxford University Press.
8. Ball, D. W. (2017),**Physical Chemistry,** 2nd Edition,Cengage Learning, India.
9. Castellan, G. W. (2004),**Physical Chemistry**, 4th Edition, Narosa.

Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have **science stream** in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester, C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practical Work]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: First year**	**Semester: III**
Peadagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		

Course Code: CHE-23103	Course Title: Lab work based on chemical Thermodynamics

Course Objectives: This course is designed to give practical knowledge about the theory taught about thermodynamics**.**

Course Outcome: After completing this course, the students will be able to -

CO1. Familiar with the safe working practices in chemistry laboratory.
CO2. Able to handle the apparatus, chemicals and equipment safely.
CO3. Find the heat change in different types of chemical reactions.
CO4: Able to understand working protocols related to Thermochemistry.

Credit: 0+0+2	Compulsory
Max. Marks: 40+60 (30T+30P)	Min. Passing Marks:35

Total Number of Practical (Lecture + Tutorial + Practical): 0 + 0 + 2

Unit	List of Practicals	No. of Practical (Hrs)
	Thermochemistry: Determination of heat capacity of a calorimeter for different volumes using (i) change of enthalpy data of a known system and (ii) heat gained equal to heat lost by cold water and hot water respectively. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide. Determination of the enthalpy of ionization of ethanoic acid. Determination of integral enthalpy (endothermic and exothermic) solution of salts. Determination of basicity of a diprotic acid by the thermochemical method for different additions of a base. Determination of enthalpy of hydration of salt. To study the effect of concentration of solute on elevation of boiling point of water. To study the elevation in boiling point on adding same concentrations of electrolyte and non-electrolyte to a specific volume of water.	**60**

Suggested Readings:

Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), Senior Practical Physical Chemistry, R. Chand & Co, New Delhi.

Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education.

Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York.

Lab manual

Course prerequisite: To study this course, the students must have **science stream** in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester, C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Second Year	Semester: III
Pedagogy: Class participation and engagement, Weekly assignments and quizzes, Research project or paper, Final presentation and discussion		
Course Code: CHEIKS-2302	**Course Title: Applied IKS-1 : Chemistry**	
Course Objectives: This course explores the integration of traditional Indian knowledge systems with modern concepts in chemistry. It aims to provide students with insights into how ancient Indian philosophies, practices, and methodologies can be applied to enhance the understanding and application of various chemical principles and processes. The course will cover a range of topics, including the philosophical foundations of Indian knowledge systems, historical contributions to chemistry, herbal chemistry, metallurgy, alchemy, and more.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Explain Basic principles of chemistry in Indian philosophical texts CO. 2 Explain Historical Contributions to Chemistry in Ancient India CO. 3 Understanding herbal compounds and their therapeutic applications CO. 4 Explain conceptual transmutation of alchemical, extraction and purification. CO. 5. Practical Applications of Indian knowledge in modern Chemistry		
Credit: 2+0+0	**Paper: Core Compulsory**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials +Practical): 30+0+0		
Unit:	**Topics**	**Lectures (Hrs.)**
Unit 1: Introduction to Indian Knowledge Systems and Chemistry • Overview of Indian philosophies (Vedas, Upanishads, Ayurveda) and their relevance to science • Basic principles of chemistry in Indian philosophical texts		06
Unit 2: Historical Contributions to Chemistry in Ancient India • Achievements of ancient Indian chemists (Nagarjuna, Charaka, Sushruta) • Extraction and processing of minerals and metals in ancient India		06
Unit 3: Herbal Chemistry and Ayurveda • Understanding herbal compounds and their therapeutic applications • Extraction techniques in Ayurvedic medicine		06
Unit 4: Alchemy and Metallurgy in Indian Context • Exploring the concept of transmutation in alchemical texts • Traditional methods of metal extraction and purification		06
Unit 5: Practical Applications of Indian Knowledge in Modern Chemistry • Comparative analysis of traditional practices and modern chemical techniques • Case studies: Ayurvedic formulations, eco-friendly processes inspired by ancient methods		06
Suggested Readings: • "Traditional Herbal Medicine in India" by P. Pushpangadan and L. Geethakumari • "Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare • "Ethnobotany and Medicinal Plants of India and Nepal" by K. L. Mehra and A. K. Joshi • "Indian Systems of Medicine: A Brief Profile" by M. S. Valiathan		

• "Ayurvedic Pharmacopoeia of India"
Course prerequisite: To study this course, the students must have had subject biology in class 12th
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

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Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Second Year**	**Semester: III**
Pedagogy: lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self Problem solving to enhance comprehension.		
Course Code: MCHE03	**Course Title: *Green Chemistry-Sustainable Science***	
Course Objective: To equip learners with foundational understanding and skills to apply chemistry in a way that promotes sustainability and environmental responsibility along with principles & practices of environmentally friendly chemical processes and products. To develop the achieving measurable reduction in greenhouse gases emission and pollutants.		
Course outcome: After completing this course, the student will be able to -		
CO.1 Explain different methods of synthetic Chemistry. **CO.2** Aware about benefit of sustainable chemistry & chemical process. **CO.3** Design safer Chemicals & chemical products. **CO.4** Awareness about chemical alternatives including toxicity, waste generation & energy consumption. **CO.5** Handle case studies related to sustainability, ethical decision making and Chemical process & products.		
Credit: 3+0+0	**Paper: Elective**	
Max. marks: 100(40+60)	**Min passing Marks: 35**	
Total No. Of Lectures: 45+0+0		

Unit	Topic	No. of lectures
Unit I	**Introduction of synthetic Chemistry** Basic of Synthetic methods of Chemicals in different industries such as, Chemical processes in Food Industries, Polymer industries, Paint Industries, Pharmaceutical Industries, Leather Industries, Beverages.	10
Unit II	**Concept of Sustainability:** Definition and Principles of sustainable development. Concept of Economy, Environmental and Social sustainability**.** Goal of sustainability**.** principles of sustainable and green chemistry	15
Unit- III	**Design of safer chemicals:** Adverse effect of chemicals on health and environment. Analysis and development of Green industrial processes. Catalytic methods in green	8

	synthesis, safer chemicals - different basic approaches; selection of auxiliary substances (solvents, separation agents).	
Unit IV	**Energy Resources** Concept and demand of energy, growing energy needs, renewable and non-renewable sources, toxicity, waste generation and use of alternate energy sources, Wind energy, Solar energy, water as source of energy, Biofuels production, use and sustainability	5
Unit V	**Case Study** Case studies related to sustainability and Chemistry : Nanotechnology in Green Chemistry : Industrial Green Catalyst : Environmental engineering, ethics in decision making and Pollution Prevention. : Green Building Design	7

Suggested Readings:

1.Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007
2.. Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York, 2001
3.. Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford Univ. Press: Oxford, 1998.
4 Lynn E. Foster: Nanotechnology: Science, Innovation, and Opportunity, December 21, 2005, Prentice Hall.
5. Fei Wang &Akhlesh Lakhtakia (eds) (2006). Selected Papers on Nanotechnology— Theory & Modelling (Milestone Volume 182). SPIE Press.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Other Courses to Opt:

AEC : Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course (VAC): To be Choosed from POOL D

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SEMESTER IV

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Second Year**	**Semester: IV**
Pedagogy: Lectures in class rooms, Hands-on learning using 3-D models, Videos, Presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE-23104	**Course Title: Chemistry of Hydrocarbons**	

Course Objectives: The course Organic Chemistry is designed in a manner that gives a better understanding of the organic functional groups, which include halogenated hydrocarbons and oxygen containing functional groups and their reactivity patterns. The detailed reactions mechanistic pathways for each functional group will be discussed to unravel the spectrum of organic chemistry and the extent of organic transformations.

Course Outcome: After completing this course, the students will be able to -

CO.1 Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.

CO.2 Learn and identify many organic reaction mechanisms including Free Radical Substitution and Electrophilic Addition .

CO.3 Use the synthetic chemistry learnt in this course to do functional group transformations.

CO.4. Understand preparation, properties and reactions of haloalkanes, haloarenes and oxygen containing functional groups.

CO.5 Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.

Credits: 3+0+2	**Paper: Core Compulsory**
Max. Marks: 40+60	**Min. Passing Marks:35**

Total Number of Lectures (Lecture + Tutorial + Practical): 45 + 0 + 60

Unit	**Topics**	No. of Lectures
Unit I	**Carbon-Carbon sigma bonds (Alkanes and Cycloalkanes):** General methods of preparation- Wurtz and Wurtz Fittig reaction, Corey House synthesis, physical and chemical properties of alkanes, Free radical substitutions; Halogenation, concept of relative reactivity v/s selectivity. Conformational analysis of alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane).General molecular formulae of cycloalkanes and relative stability, Baeyer strain theory, Cyclohexane conformations with energy diagram, Axial and equatorial positions. Conformations of monosubstituted cyclohexanes.	8
Unit II	**Carbon-Carbon pi Bonds (Alkenes and Alkynes)**: Structure and isomerism.General methods of preparation, physical and chemical properties. Mechanism, of E1, E2, E1cb reactions, Saytzeff and Hoffmann eliminations, Electrophilic Additions, mechanism with suitable examples, (Markownikoff/Antimarkownikoff addition), syn and anti-addition; addition of H2, X2, oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, hydroxylation, Diels Alder reaction, 1,2-and 1,4-addition reactions in conjugated dienes. Mechanism of allylic and benzylic bromination in propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes; acidity, electrophilic and nucleophilic additions, hydration to form carbonyl compounds, Alkylation of terminal alkynes.	10

Unit III	**Alcohol, Phenol, Ether and Epoxides:** Alcohols: Monohydric alcohols – Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric and trihydric alcohols: Methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc)4 and HIO4] and pinacol-pinacolone rearrangement. Trihydric alcohols – Methods of formation, chemical reactions of glycerol. **Phenols:** Acidic character of phenols, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation, Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben – Hoesch reaction, Lederer – Manassereaction and Reimer – Tiemann reaction. **Ethers and Epoxide:** Ethers – Williamson's synthesis, Reaction with HX. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reaction of Grignard and organolithium reagents with epoxides. **Chemistry of Halogenated Hydrocarbons:** Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution vs. elimination. Aryl halides: Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; SNAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.	8
Unit IV	**Carbonyl Compounds:** Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, WolffKishner, LiAlH4, NaBH4, MPV, PDC) Addition reactions of α, β- unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.	10
Unit V	**Carboxylic acids and their derivatives:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids. Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group-Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hoffmann-bromamide degradation and Curtius rearrangement.	9

Suggested Readings:

1. Morrison, R. N.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), Intermediate for Organic Synthesis, I.K.International.
4. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
5. Chandra, R. ; Singh, S.; Singh, A. (2019), Organic reactions and their nomenclature, Arcler Press.

Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have **science stream** in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under

;Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Practicals List]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: IInd Year**	**Semester: IV**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23104	**Course Title: Lab work based on theory**	
Course Objectives: This course is designed to give hands on experience about organic preparation, purification, melting, boiling point determination of organic compounds. This course also provide knowledge about chromatographic separation of compounds.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Familiar with the safe working practices in chemistry laboratory. CO2. Handle the melting point apparatus. CO3. Familiar with purification, meting point, boiling point and organic preparation of compounds. CO4: Understand the protocol of chromatographic separation.		
Credit: 0+0+2	**Paper: Core Compulsory**	
Max. Marks: 100(40+60)	**Min. Passing Marks:35**	
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 2		

Unit	Topics	No. of Practical (Hrs)

1.Calibration of a thermometer. 2. Organic Preparation (any one of the following): a. Bromination of acetanilide/aniline/phenol b. Nitration of nitrobenzene/toluene c. Aldol condensation using either conventional or green method. 3. Purification of organic compounds by crystallization using the following solvents: a. Water b. Alcohol c. Alcohol-Water 4. Determination of the melting points of prepared organic compounds (Kjeldahl method and electrically heated melting point apparatus) 5. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds. 6. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method) 7. Chromatography a. Separation of a mixture of two amino acids by ascending and radial paper chromatography b. Separation of a mixture of two sugars by ascending paper chromatography. c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC). **Suggested Readings:** 1. Mann, F. G.; Saunders, B. C. (2009), Practical Organic Chemistry, Pearson Education. 2. Ahluwalia, V.K.; Dhingra, S. (2004),Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press. 3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson. 4. Leonard, J.; Lygo, B.; Procter, G. Advanced Practical Organic Chemistry, CRC Press. 5. Lab Manual.	**60**
Course prerequisite: To study this course, the students must have **science stream** in class 12th.	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

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Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Second Year**	**Semester: IV**
Pedagogy: lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self Problem solving to enhance comprehension		
Course Code: MCHE04	**Course Title: *Chemical Biology- Chemistry Meet life sciences***	

Course Objectives: The objective of this course is to deliver information about biochemically significant features of the chemistry such as amino acids, carbohydrates, proteins, enzymes, nucleic acids and lipids, using suitable examples. This includes classification, reaction chemistry and biological importance of these biomolecules. This course extends the knowledge gained from synthetic organic chemistry to chemistry of biomolecules. Key emphasis is placed on understanding the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural detail. {*Chemistry is fundamentally important in studying biology because* **it provides the foundation for understanding the chemical processes that sustain life**.}

Course Outcome: After completing this course, the students will be able to -

CO.1 Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.
CO.2 Gain an insight into mechanism of enzyme action and inhibition.
CO.3 Understand biological processes like replication, transcription and translation.
CO.4 Demonstrate an understanding about lipids.
CO.5 Dyes / Contrast agents used in study of medicine/diagnostic & how they are related to chemical biology.

Credit: 3+0+0	**Paper: Elective**
Max. marks: 100(40+60)	**Min passing Marks: 35**
Total No. Of Lectures: 45+0+0	

Unit	Topic	No. of lectures
Unit I	**Carbohydrates:** Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.	10
Unit II	Amino Acids, Peptides and Proteins Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C– terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.	15
Unit-III	Nucleic Acids Components of Nucleic acids: Adenine, guanine, thymine, cytosine & uracil (structure only), other components of nucleic acids, nucleosides and nucleotides (nomenclature), structure of polynucleotides; structure of DNA (Watson-Crick model) and RNA(types of RNA),difference between DNA and RNA, genetic code, biological roles of DNA and RNA: replication, transcription and translation.	8
Unit IV	Lipids Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega-3&6 fatty acids, trans fats, hydrogenation, hydrolysis, acid value, saponification value, iodine number. Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).	5
Unit V	**Dyes/Contrast agents:** Colour and constitution. Classification of dyes. A general study of various dyes & contrast agents, mechanism of action & application in medicine and chemical biology.	7

Suggested Readings: 1. Medicinal Chemistry by Ashutosh Kar. 2. Drugs and Pharmaceutical Sciences Series, Marcel Dekker, Vol. II, INC, New York. 3. Chemical Biology: Learning through case studies by Herbert Waldmann & Petra Janning. 4. Chemical Biology: Techniques & Applications by Andrew Almonds & Igor V. Komarov. 5. Chemical Biology: Approaches to drug discovery & Development to targeting disease by Natanya Civjan. 6. Royal Society of Chemistry – Chemical Biology Series 7. Libre Texts on Chemical Biology (Open Access resources). 8. Introduction to Bioorganic Chemistry & Chemical Biology by David Van Vranken & Gregory A. Weiss. 9. DrugBank Online; Radiologyinfo.org; PubMed Central (PMC); StatPearls.
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses:

AEC: Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Chosen from POOL C
Value Added Course (VAC): To be Chosen from POOL D

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Exit Option: Undergraduate Diploma (in the field of learning/discipline)for those who exit after two years (four semesters) of the undergraduate programme (Programme duration: First twoyears or four semesters of the undergraduate programme) **[NHEQF 5.0]**

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SEMESTER-V

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: V**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Course Code: CHE-23105	**Course Title: Conductance, Chemical Kinetics, Phase Equilibria and Electrochemical Cells**	
Course Objectives: This course aims to make the students understand conductance, anomaly of strong electrolytes, laws governing migration of ions in solutions and application of conductance measurement for titration methods and have understanding of kinetics of chemical reaction, catalysis and photochemical. The aim of this course is to make students understand phase, co-existence of phases,		

phase diagram and distribution law and concepts of electrochemical cells, electrode potential, electrochemical series and learn about surface phenomenon, adsorption isotherms, BET Equation.

Course Outcome: After completing this course, the students will be able to -

CO.1 Explain the chemistry of conductance & its variation with dilution, migration of ions in solutions and applications of conductance measurements.
CO.2 Have understanding of rate law and rate of reaction, theories of reaction rates and catalysts; both chemical and enzymatic
CO.3 Understand phase equilibrium, Gibbs-Duhem-Margules equation.
CO.4. Have knowledge of the laws of absorption of light energy by molecules and the subsequent photo chemical reactions.
CO.5 Learn the working of electrochemical cells, galvanic cell, corrosion and happenings in surroundings related to electrochemistry.

Credits: 2+0+2	**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 30 + 0 + 60

Unit	**Topics**	No. of Lectures
Unit I	**Conductance:** Quantitative aspects of Faraday's laws of electrolysis, Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch's law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rule. Ionic velocity, mobility and their determination, transport number and its relation to ionic mobility, determination of transport number using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations,(v) hydrolysis constants of salts..	6
Unit II	**Chemical Kinetics:** Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods for determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates. **Catalysis:** Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.	7

Unit III	**Phase Equilibria:** Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems, Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H2O and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points. Nernst distribution law: its derivation and applications. **Surface chemistry:** Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Qualitative discussion of BET.	5
Unit IV	**Photochemistry:** Characteristics of electromagnetic radiation, Jablonski Diagram. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching, chemiluminescence.	5
Unit V	**Electrochemical Cells:** Rules of oxidation/reduction of ions based on half-cell potential. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).	7

Suggested Readings:

Peter, A.; Paula, J. de. (2011), Physical Chemistry, 9th Edition, Oxford University Press.
Castellan, G. W. (2004),Physical Chemistry, 4th Edition, Narosa.
Kapoor, K.L. (2015),**A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.
Kapoor, K.L.(2015),A Textbook of Physical Chemistry,Vol 2, 6th Edition, McGraw Hill Education.
Kapoor, K.L.(2013),A Textbook of Physical Chemistry,Vol 3, 3rd Edition, McGraw Hill Education.
McQuarrie, D. A.; Simon, J. D. (2004),Molecular Thermodynamics, Viva Books Pvt. Ltd. .
Atkins, P.W.; Paula, J.de. (2014),**Atkin's Physical Chemistry Ed**., 10th Edition, Oxford University Press.
Ball, D. W. (2017),**Physical Chemistry,** 2nd Edition,Cengage Learning, India.
Castellan, G. W. (2004),**Physical Chemistry**, 4th Edition, Narosa.

Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx
https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have had science stream in class 12th .

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

[Lab Work/Practicals List]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: V**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23105	**Course Title: Lab work based on theory**	
Course Objectives: Aim to give practical knowledge about conductance, kinetics, phase diagram and potentiometric titration.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Learn conductance measurements hands on experience. CO2. Study Kinetics of reaction. CO3. Construct Phase diagram of reaction CO4: Perform Potentiometric titration of reactions.		
Credit: 0+0+2	**Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**	
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 2		

Unit	List of Practicals	No. of Practical (Hrs)
	Conductance 1. Determination of cell constant 2. Determination of conductivity, molar conductivity, degree of dissociation and dissociation constant of a weak acid. 3. Perform the following conductometric titrations: i. Strong acid vs. strong base, ii. Weak acid vs. strong base, iii. Mixture of strong acid and weak acid vs. strong base, iv. strong acid vs. weak base. **Chemical Kinetics:** 1. To study the kinetics of Acid hydrolysis of methyl acetate with hydrochloric acid using integrated rate law method. 2. To study the kinetics of Iodide-persulphate reaction by Initial rate method. 3. To study the kinetics of iodine-persulphate reaction using integrated rate law method. 4. To study the kinetics of iodine clock reaction. 5. To study the kinetics of Saponification of ethyl acetate. 6. Comparison of the strengths of HCl and H2SO4 by studying the kinetics of hydrolysis of methyl acetate. 7. To determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride in aqueous Solution. **Phase Equilibria:**	**60**

1.Determination of critical solution temperature and composition at CST of the phenol water system and to study the effect of impurities of sodium chloride and succinic acid on it. 2. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems. 3. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane. 4. Study of equilibrium of any one of the following reactions by distribution method: (a) I2 (aq) + I- (aq) ⇌ I3 - (aq) (b) Cu2+ (aq) + nNH3⇌ [Cu(NH3)n] 5. Perform the following potentiometric titrations: i. Strong acid vs. strong base ii. Weak acid vs. strong base iii. Dibasic acid vs. strong base iv. Potassium dichromate vs. Mohr's salt.	
Suggested Readings: 1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015),Senior Practical Physical Chemistry, R. Chand & Co, New Delhi. 2. Kapoor, K.L. (2019),A Textbook of Physical Chemistry, Vol.7, 1st Edition, McGraw Hill Education. 3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P.(2003),Experiments in Physical Chemistry, 8th Edition, McGraw-Hill, New York. 4. https://edu.rsc.org/resources/practical/experiments **5.** Lab Manual	
Course Prerequisite: This course can be opted as an elective by the students science stream in 12th Class	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

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Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: V**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, problem solving to enhance comprehension.		
Course Code: CHEIKS-2303	**Course Title: Applied IKS-2 : Chemistry**	
Course Objectives: This course explores the integration of traditional Indian knowledge systems with modern concepts in chemistry. It aims to provide students with insights into how ancient Indian philosophies, practices, and methodologies can be applied to enhance the understanding and application of various chemical principles and processes. The course will cover a range of topics, including the philosophical foundations of Indian knowledge systems, historical contributions to chemistry, herbal chemistry, metallurgy, alchemy, and more.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand and explain Panchabhuta with chemical elements CO. 2 Have understanding of Role of meditation in chemical insight CO. 3 Explain traditional ecological concepts with modern environmental chemistry CO. 4 Explain ethical and moral dimensions of Chemistry CO. 5. Have understanding synthesis of modern and traditional approaches		

Credit: 2+0+0		Paper: Core Compulsory
Max. Marks: 100(40+60)		Min Passing Marks: 35
Total Number of Lectures (Lecture +Tutorials +Practical): 45+0+0		
Unit	**Topics**	**No. Of Lectures (Hrs.)**
Unit-I	**Philosophy of Five Elements (Panchabhuta) and Chemical Principles** • Understanding the concept of Panchabhuta in Indian philosophy • Correlation of Panchabhuta with chemical elements and compounds	**6**
Unit-II	**Unit-2: Yoga and Meditation in Chemical Research** • Exploring the role of meditation and focused concentration in chemical insights Mind-body connection in the laboratory.	6
Unit-III	**Unit-3: Environmental Wisdom and Sustainable Chemistry** • Traditional ecological knowledge and its applications in modern environmental chemistry • Eco-friendly practices from Indian traditions	6
Unit-IV	**Unit-4: Ethical and Moral Dimensions of Chemistry** • Ethical considerations in chemical research and industrial applications • Integrating Indian ethical principles with modern scientific practices	6
Unit-V	**Unit-5: Synthesis of Modern and Traditional Approaches** • Developing a holistic perspective on chemistry by integrating Indian and Western knowledge systems • Future prospects and interdisciplinary research opportunities	6

Suggested Readings:

- "Traditional Herbal Medicine in India" by P. Pushpangadan and L. Geethakumari
- "Indian Medicinal Plants: An Illustrated Dictionary" by C.P. Khare
- "Ethnobotany and Medicinal Plants of India and Nepal" by K. L. Mehra and A. K. Joshi
- "Indian Systems of Medicine: A Brief Profile" by M. S. Valiathan
- "Ayurvedic Pharmacopoeia of India"

Course prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Minor Course [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: V**
Pedagogy: lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self Problem solving to enhance comprehension.		
Course Code: MCHE05	**Course Title:** ***Renewable Energy Resources***	
Course Objectives: Provide students with a comprehensive understanding of renewable energy resources, their technologies, innovations, and real-world applications. Introduction to interdisciplinary approaches to solving global energy challenges considering technological, economic, environmental, and social factors.		
Course outcome: After completing this course, the student will be able to -		
CO.1 Understand the global energy landscape and the need for renewable energy. **CO.2** Gain knowledge of current energy generation and the latest technologies and innovations in solar systems. **CO.3** Understand energy storage technologies and their role in enabling renewable energy integration with real life examples. **CO.4** Familiarize with cutting-edge innovations in renewable energy technologies **CO.5**. Understand the future challenges and opportunities in renewable energy technologies.		
Credit: 3+0+0	**Paper**: Elective	
Max. marks: 100(40+60)	**Min passing Marks**: 35	
Total No. Of Lectures: 45+0+0		

Unit	**Topic**	**No. of lecture**
Unit I	**Introduction to Renewable Energy** o Definition and Importance of Renewable Energy o Global Energy Trends and Environmental Concerns (Climate Change, Fossil Fuels) o Overview of Renewable Energy Sources (Solar, Wind, Hydro, Biomass, Geothermal) o Energy Transition and Sustainable Development Goals (SDGs)	10
Unit II	**Different Types of Energy Technologies** ➢ Solar Energy Technologies ➢ Geothermal Energy ➢ Wind Energy Technologies ➢ Hydro Energy and Ocean Energy ➢ Biomass and Bioenergy: Sources: Agricultural Residues, Forest Residues, Algae. Biofuels: Ethanol, Biodiesel, and Next-Gen Biofuels (Cellulosic, Algal). Biogas Production and Waste-to-Energy Technologies. Innovations in Biorefinery Concepts. Environmental Impacts and Sustainability.	15
Unit-III	**Energy Storage Technologies** Importance of Energy Storage in Renewable Integration o Battery Storage: Lithium-ion, Solid-state, Flow Batteries, and Innovations o Grid-Scale Storage and Pumped Hydro o Hydrogen Storage and Power-to-X Technologies o Challenges in Energy Storage and Grid Management.	8
Unit IV	**Innovations and Emerging Trends in Renewable Energy** o Energy Harvesting Technologies (e.g., Piezoelectric and Thermoelectric) o Artificial Photosynthesis and Solar Fuels	5

	o Nanotechnology in Solar and Wind Power o Quantum Dot Solar Cells o Block chain in Energy Systems and Decentralized Energy Trading.	
Unit V	F**uture of Renewable Energy and Sustainability** o Vision for a Renewable Energy Future: 100% Renewable Energy o Integration of Renewables into Urban Planning and Smart Cities o Life Cycle Assessment and Circular Economy in Energy Systems o Role of Artificial Intelligence and Machine Learning in Renewable Energy Optimization o Global Trends and Future Challenges	12
Suggested Readings: 1. **"Renewable Energy: Power for Sustainable Future"** by Godfrey Boyle {C} 2. **"Introduction to Renewable Energy"** by Vaughn Nelson {A} 3. **"Renewable Energy Technologies: Their Applications"** by John R. S. Evans {D} 4. **"Sustainable Energy - Without the Hot Air"** by David MacKay {E} 5. **"Fundamentals of Renewable Energy"** by Roberto Rocco {B}		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

ELECTIVE (MAJOR) FOR CHEMISTRY DISCIPLINE CHOOSE ANY ONE

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: V**
Subject: Chemistry		
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE-23106A	**Course Title:** Industrial Chemicals & Environment	
Course Objectives: The objective of this course is to teach the Chemistry of the general industrial separation and purification techniques. Production, uses and hazards associated with different industrial gases and chemicals. Air pollution, air pollutants, pollutants control procedures, greenhouse effect, global warming, water pollution, water pollutants, industrial effluents and their treatment, water quality parameters and water purification techniques.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Know the various separation and purification techniques used in industries like distillation, solvent extraction, absorption, adsorption etc. CO.2 Know the production, uses and hazards of important gases like oxygen, helium, argon, hydrogen, acetylene, ammonia etc. CO.3 Know the production, uses and hazards of important inorganic chemicals like hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, potassium hydroxide etc. CO.4 Learn about air pollution, air pollutants, their control procedure, global warming, ozone depletion. CO.5 Learn about water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.		
Credit: 1+0+2	**Paper: Elective**	

Max. Marks: 100(40+60)	Min Passing Marks: 35	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		
Unit	**Topics**	**No. of Lecture**
Unit I	General industrial processes: Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption	3
Unit II	**Industrial Gases:** (a) Industrial Gases: Production, uses and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, chlorine, fluorine and ammonia.	3
Unit III	**Inorganic Chemicals**: Inorganic Chemicals: Production, uses and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, sodium hydroxide, potassium hydroxide bleaching powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.	3
Unit IV	**Environment:** (a) Air Pollution: Pollutants and their sources, pollution by SO2, CO, NOx. Methods of estimation of CO, NOx, SOx and their control procedures. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, Particulate matter and its types.	3
Unit V	**Environment:** (b) Water Quality Standards and Water pollution: Water quality parameters like pH, alkalinity, DO, BOD, COD, chloride, sulphate, available chlorine etc. Water treatment and purification processes (reverse osmosis, electro dialysis, ion exchange). Pollutants and their sources. Effluent treatment (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy and petrochemicals and agrochemicals.	3

Suggested Readings:

1. Stocchi, E. (1990), Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. Kent, J. A. (ed.) (1997), Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
3. Austin, G.T (2012), Shreve's Chemical Process Industries, Tata McGraw-Hill Education Private Limited.
4. Girard, J.E, (2011), Principles of Environmental Chemistry, Jones & Bartlett India Pvt. Limited.
5. Sodhi, G.S. ((2013), Fundamental Concepts of Environmental Chemistry, Narosa Publishing House.
6. Vermani, O.P; Narula, A.K. (2012), Industrial Chemistry, Galgotia Publishing Pvt. Limited.
7. Sharma, B.K. (2011), Industrial Chemistry, Goel Publishing House.
8. Pani, B. (2017), Textbook of Environmental Chemistry, I.K. International Publishing House.
9. De, A. K. (2015), Environmental Chemistry, New Age International Pvt, Ltd, New Delhi
10. Khopkar, S.M. (2012), Environmental Pollution Analysis, New Age International Publisher.

Course prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks

Internal Class Test – 10 Marks

Attendance/Behavior – 05 Marks

[Lab Work/Practicals)

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: V**
Pedagogy: As the best way to learn something is to do it yourself, practicals are planned in such a way so as to reinforce the topics covered in theory.		
Course Code: CHE-23106A	**Course Title: Lab work based on theory**	
Course Objective: Aim to design impart understanding of experimental skill for determination of BOD, COD, DO, total alkalinity etc. of sample.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Determination of dissolved oxygen, COD, BOD in water. CO2. Estimate of total alkalinity of water samples . CO3. Determine Percentage of available chlorine in bleaching powder . CO4: Gain experimental skill.		
Credit: 2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min. Passing Marks:35**	
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60		

Unit	**Practicals List**	**No. of Practical (Hrs)**
	1. Determination of dissolved oxygen in water. 2. Determination of Chemical Oxygen Demand (COD). 3. Determination of Biological Oxygen Demand (BOD). 4. Measurement of chloride and sulphate ions of water samples by simple titration method. (With AgNO3 and potassium chromate). 5. Measurement of salinity of water samples by simple titration method. (With AgNO3 and potassium chromate). 6. Estimation of total alkalinity of water samples (CO3 2- , HCO3 -) using double titration method. 7. Determination of Percentage of available chlorine in bleaching powder. 8. Isolation of compound using solvent extraction method.	**60**
	Course Prerequisite: This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class	
	Suggested Readings: 1. Bassett,J.; Denney, R.C.; Jeffery, G.H.; Mendham, J.(1996) Vogel Textbook of quantitative inorganic analysis, 7th edition, ELBS edition.Prentice Hall Publications. 2. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; Vogel's Text Book of Practical Organic Chemistry, 5th Edition, Longman Scientific and Technical, Longman Group Ltd. 3. Mittal, K.; Chandra, L.(2013) Experiments in organic chemistry, Anne Books Pvt. Limited. 4. Gulati, S.; Sharma, J.L.; Manocha, S. (2017)Practical Inorganic Chemistry. CBS, Publications. 5. Rogers, A. (2015) Laboratory Guide of Industrial chemistry, Palala Press. 6.Lab Manual	

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: V**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE-23106B	**Course Title:** Polymer Chemistry	
Course Objectives: The primary objective of this paper is to help the student to know about the synthesis, properties and applications of polymers.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Know about history of polymeric materials and their classification. CO.2 Learn about different mechanisms of polymerization and polymerization techniques. Evaluate kinetic chain length of polymers based on their mechanism CO.3 Differentiate between polymers and copolymers • Learn about different methods of finding out average molecular weight of polymers. CO.4 Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm) . CO.5 Know about solid and solution properties of polymers. Learn properties and applications of various useful polymers in our daily life.		
Credit: 1+0+2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

Unit	**Topics**	**No. of Lecture**
Unit I	Introduction and history of polymeric materials: History of polymeric materials, Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers Functionality and its importance: Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization Bifunctional systems, Poly-functional systems	3
Unit II	Kinetics of Polymerization Mechanism of step growth polymerization, kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic), Mechanism and kinetics of copolymerization, polymerization techniques	3
Unit III	Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg). Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. Nature and structure of polymers-Structure Property relationships	3
Unit IV	Determination of molecular weight of polymers (Mn, Mw, etc.) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular	3

	weight distribution and its significance. Polydispersity index Polymer Solution Criteria for polymer solubility and Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy and free energy change of mixing of polymers solutions Polymer Degradation Thermal, oxidative, hydrolytic and photodegradation	
Unit V	Properties of Polymers (Physical, thermal, Flow & Mechanical Properties) Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers: polyacetylene, polyaniline, poly(p-phenylene sulphide, polypyrrole, polythiophene	3

Suggested Readings:

1. Carraher,C. E. Jr. (2013), Seymour's Polymer Chemistry, Marcel Dekker, Inc.
2. Odian, G. (2004), Principles of Polymerization, John Wiley.
3. Billmeyer, F.W. (1984),Text Book of Polymer Science, John Wiley.
4. Ghosh, P. (2001),Polymer Science & Technology, Tata Mcgraw-Hill.
5. Lenz, R.W. (1967),Organic Chemistry of Synthetic High Polymers, Intersecience (Wiley).

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks

Internal Class Test – 10 Marks

Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: V**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23106B	**Course Title: Lab work based on theory**

Course Objective: Aim to design impart understanding of experimental skill for preparation of polymer, characterize polymer and analyse polymer.

Course Outcome: After completing this course, the students will be able to -

CO1. Synthesize polymer.
CO2. Characterize polymer.
CO3. Analyse polymer.
CO4: Gain experimental skill.

Credit: 0+0+2	**Paper: Elective (Majo**

Max. Marks: 100(40+60)	Min. Passing Marks:35
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60	

Unit	List of Practicals	Practical (Hrs)
	Polymer synthesis: 1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA). 2. Preparation of nylon 6,6 3. Redox polymerization of acrylamide 4. Precipitation polymerization of acrylonitrile 5. Preparation of urea-formaldehyde resin 6. Preparations of novalac resin/resold resin. 7. Microscale Emulsion Polymerization of Poly(methylacrylate). **Polymer characterization:** 1. Determination of molecular weight of polyvinyl propylidene in water by viscometry: 2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer. 3. Determination of molecular weight by end group analysis of polymethacrylic acid. **Polymer analysis**: 1. Estimation of the amount of HCHO in the given solution by sodium sulphite method .2. IR studies of polymers 3. DSC (Differential Scanning Calorimetry) analysis of polymers 4. TG-DTA (Thermo-Gravimetery-Differential Thermal Analaysis) of polymers	**60**
	Suggested Readings: 1. Allcock, H.R.; ; Lampe, F. W.; Mark, J. E.(2003),Contemporary Polymer Chemistry, PrenticeHall. 2. Fried, J.R. (2003), Polymer Science and Technology, Prentice-Hall. 3. Munk, P.; Aminabhavi, T. M. (2002), Introduction to Macromolecular Science, John Wiley & Sons. 4. Sperling, L.H.(2005),Introduction to Physical Polymer Science, John Wiley & Sons. 5.Lab Manual	
	Course. prerequisite: To study this course, the students must have had subject biology in class 12th	
	Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Third Year	Semester: V

Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.

Course Code: CHE-23106C	**Course Title:** Chemistry of Cosmetics and Perfumes

Course Objectives: Cosmetic plays an important role in our everyday lives as they make an individual's appearance more attractive and boost one's self-esteem and confidence. Keeping in view the tremendous potential which the cosmetic industry has today around the globe, this course will be useful for introducing students of Chemistry honours to the world of cosmetic chemistry. This has been designed to impart the theoretical and practical knowledge on basic principles of cosmetic chemistry, manufacture, formulation of various cosmetic products.

Course Outcome: After completing this course, the students will be able to -

CO.1 Learn basic of cosmetics, various cosmetic formulation, ingredients and their roles in cosmetic products. • Learn the use of safe, economic and body-friendly cosmetics • Prepare new innovative formulations. Know the various separation and purification techniques used in industries like distillation, solvent extraction, absorption, adsorption etc.

CO.2 Know the production, uses and hazards of important gases like oxygen, helium, argon, hydrogen, acetylene, ammonia etc.

CO.3 Know the production, uses and hazards of important inorganic chemicals like hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, potassium hydroxide etc.

CO.4 Learn about air pollution, air pollutants, their control procedure, global warming, ozone depletion.

CO.5 Learn about water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.

Credit: 1+0+2	**Paper: Elective (Major)**
Max. Marks: 100(40+60)	**Min Passing Marks: 35**

Total Number of Lectures (Lecture +Tutorials + Practical):15+0+60

Unit	**Topics**	**No. of Lecture**
Unit I	**Cosmetics:** Definition, History, Classification, Ingredients, Nomenclature, Regulations.	3
Unit II	**Face Preparation:** Structure of skin, Face powder, Compact powder, Talcum powder.	3
Unit III	**Skin Preparation:** Face cream, vanishing cream, cold cream, suntan cream, lather shaving cream	3
Unit IV	**Hair preparation:** Structure of hair, classification of hair, Hair dye- classification – temporary, semipermanent, demi permanent, permanent, formulation, hair sprays, shampoo- types of shampoo, conditioners	3
Unit V	**Colored preparation:** Nail preparation Structure of nail, Nail lacquers, Nail polish remover Lipsticks **Personal hygiene products:** Antiperspirants and deodorants, oral hygiene products, flavours and essential oils	3

Suggested Readings:

1. Barel, A.O.; Paye, M.; Maibach, H.I.(2014),Handbook of Cosmetic Science and Technology, CRC Press.
2. Garud, A.; Sharma, P.K.; Garud, N. (2012),Text Book of Cosmetics, Pragati Prakashan.
3. Gupta, P.K.; Gupta, S.K.(2011),Pharmaceutics and Cosmetics, Pragati Prakashan
4. Butler, H. (2000),Poucher's Perfumes, Cosmetic and Soap, Springer
5. Kumari, R.(2018),Chemistry of Cosmetics, Prestige Publisher.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: V**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23106C	**Course Title: Lab work based on theory**	
Course Objective: Aim to design impart understanding of experimental skill for preparation of Enamels, Face cream, Nail polish and nail polish remover, Hand wash, Hand sanitizer etc.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Synthesize Talcum Powder. CO2. Synthesize shampoo. CO3. Prepare nail polish and nail polish remover. CO4: Gain experimental skill.		
Credit: 0+0+2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min. Passing Marks:35**	
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60		

Practicals List	**No. of Practical (Hrs)**
1. Preparation of: 1. Talcum powder. 2. Shampoo. 3. Enamels. 4. Face cream. 5. Nail polish and nail polish remover. 6. Hand wash	**60**

7. Hand sanitizer 8. Body lotion 9. Soap 10. Tooth powder 11. Tooth paste	

Course Prerequisite:This course can be opted as an elective by the students of following subjects: Chemistry in 12 th Class

Suggested Readings:

1.Flick,E.W.(1990),Cosmetic and toiletry formulations, Noyes Publications / William Andrew Publishing.
2. Natural Ingredients for Cosmetics; EU Survey 2005
3. Formulation Guide for cosmetics; The Nisshin OilliO Group, Ltd.
4. Functional Ingredients & Formulated Products for Cosmetics & Pharmaceuticals; NOF Corporation
5.Lab Manual

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Other Courses:

AEC : Ability Enhancement Course
Skill Enhancement Course (SEC) : To be Chosen from POOL C
Value Added Course (VAC): To be Chosen from POOL D

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SEMESTER-VI

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Third Year**	**Semester: VI**
Pedagogy: Lectures in class rooms, Hands-on learning using 3-D models, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Course Code: CHE-23107	**Course Title: Nitrogen containing functional groups, Polynuclear Hydrocarbons, Heterocyclic Chemistry**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Gain theoretical understanding of chemistry of compounds having nitrogen containing functional groups. **CO.2** Become familiar with their particular properties, chemical reactions, criterion of aromaticity with reference to aromatic hydrocarbons and polynuclear hydrocarbons.		

CO.3 Become familiar with their particular properties, chemical reactions, criterion of aromaticity with reference to heterocyclic compounds, trends in basicity of amines and heterocyclic compounds and their behaviour at different pH.
CO.4. Understand the periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table.
CO.5 Understand oxidation states with reference to elements in unusual and rare oxidation states like carbides and nitrides

Credits: 2+0+2	**Paper: Core Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**

Total Number of Lectures (Lecture + Tutorial + Practical): 30 + 0 + 60

Unit	**Topics**	No. of Lectures
Unit I	**Nitrogen Containing Functional Groups** **Amines:** Introduction, classification, chirality in amines (pyramidal inversion), importance and general methods of preparation. Properties: Physical properties, Basicity of amines: Effect of substituents, solvent and steric effects. Distinction between Primary, secondary and tertiary amines using Hinsberg's method and nitrous acid. Discussion of the following reactions with emphasis on the mechanistic pathway: Gabriel Phthalimide synthesis, Hoffmann- Bromamide reaction, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction and Cope elimination. **Diazonium Salts:** Preparation and synthetic applications of diazonium salts including preparation of arenes, haloarenes, phenols, cyano and nitro compounds. Coupling reactions of diazonium salts(preparation of azo dyes). **B) Nitro compounds** (Aliphatic and Aromatic):Nomenclature, classification and general methods of preparation: from alkyl halides, alkanes, oxidation of amines and oximes and diazonium salts. Properties: Physical properties, discussion on the following reactions with mechanism: Reaction with alkali and its synthetic applications, condensation reaction, Mannich reaction, Hydrolysis,Reduction-electrolytic reduction, reduction in acidic, basic and neutral medium (for aromatic compounds),reaction with nitrous acid, Electrophilic substitution-Halogenation, nitration and sulphonation reaction, and Nucleophilic substitution on the ring. **C) Nitriles:** Introduction, Nomenclature and uses. Preparation from the following reactions: Dehydration of amides and aldoximes, substitution reaction in alkyl halides and tosylates, from Grignard reagents and from dehydrogenation of primary amines. Properties: Physical properties, discussion on the following reactions with mechanism: Reaction with Grignard reagent, hydrolysis,addition reaction with HX,NH3,reaction with aqueous ROH, Reduction reactions-catalytic reduction and Stephen's reaction, Condensation reactions-Thorpe Nitrile Condensation.	10

	D) Isonitriles: Introduction, Nomenclature and uses. Preparation from the following reactions: Carbylamine reaction, substitution in alkyl halides and dehydrogenation of N-substituted formamides. Properties: Physical properties, discussion on the following reactions with mechanism: Hydrolysis, reduction, addition of– HX, X2 and sulphur, Grignard reaction, oxidation and rearrangement.	
Unit II	**Aromatic Hydrocarbons:** Concept of Aromaticity, Huckel's rule, aromatic character of arenes, cyclic carbocations and carbanions with suitable examplesand heterocyclic compoundswith suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/ acylation with their mechanism. Directing effects of groups in electrophilic substitution. **Polynuclear Hydrocarbons**: Introduction, Classification,Structure, Nomenclature and uses. Aromaticity of polynuclear hydrocarbons, structure elucidation of Naphthalene and general methods of preparation of naphthalene, phenanthrene and anthracene(including Haworth method,Friedel Craft acylation, Diels Alder reaction,Elbs reaction and Pschorr Synthesis).Relative reactivity of naphthalene, phenanthrene and anthracene in comparison to benzene. Properties: Physical properties, discussion on the following reaction (with mechanism) for Naphthalene, Anthracene and Phenanthrene:	08
Unit III	**Heterocyclic compounds:** Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six – membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bishler-Napleralski synthesis. Mechanism of electrophilic substitution reactions of indole, quinoline and isoquioline.	10
Unit IV	**Chemistry of s-Block Elements**: General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates. Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. Solutions of alkali metals in liquid ammonia and their properties.	10
Unit V	**Chemistry of p- Block Elements**: Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group. Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat of the following: • Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 (EH_3 where E = N, P, As, Sb, Bi), Group	07

	16 and Group 17. • Oxides: oxides of phosphorus, sulphur and chlorine • Oxoacids: oxoacids of phosphorus and chlorine; peroxoacids of sulphur • Halides: halides of silicon and phosphorus	

Suggested Readings:

1.Morrison, R. T.; Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1& 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Solomons, T. W. G.; Fryhle, C. B. ; Snyder, S. A. (2016),Organic Chemistry, 12th Edition, Wiley.
4. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P. (2013),Organic Chemistry, Oxford University Press.
5. Gilchrist, T.L. (1997),Heterocyclic Chemistry, Pearson Education.
6. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Nomenclature and Chemistry of three to five membered Heterocycles), Elsevier publication.
7. Ram V. J.; Sethi, A.; Nath, M.; Pratap, R.; (2019), The Chemistry of Heterocycles (Chemistry of six to eight membered N, O, S, P and Se heterocycles), Elsevier publication.
8. Lee, J.D.; (2010),Concise Inorganic Chemistry, Wiley India.
9. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009),Inorganic Chemistry- Principles of Structure and Reactivity, Pearson Education.
10. Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx

Course prerequisite: To study this course, the students must have had science stream in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: VI**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23107	**Course Title: Lab work based on theory**	
Course Outcome: After completing this course, the students will be able to -		
CO1. Learn conductance measurements hands on experience. CO2. Study Kinetics of reaction. CO3. Construct Phase diagram of reaction CO4: Perform Potentiometric titration of reactions.		
Credit: 0+0+2	**Paper: Core Compulsory**	

Max. Marks: 100(40+60)	Min. Passing Marks:35
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60	
List of Practicals	**No. of Practical (Hrs)**
1. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters). 2. Isolation of caffeine from tea leaves. 3. Estimation of aniline by any one of the following methods: a) Acetylation b) Bromate-bromide method	**60**
Course Prerequisite: This course can be opted as an elective by the students of following subjects: Chemistry in 12th Class	
Suggested Readings: 1.Mann, F. G.; Saunders, B. C. (2009),Practical Organic Chemistry, Pearson Education. 2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.(2012),Vogel's Textbook of Practical Organic Chemistry, Pearson. 3. Ahluwalia, V.K.; Aggarwal, R.(2004),Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press. 4. https://edu.rsc.org/resources/practical/experiments 5.Lab Manual	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

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Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Third Year	Semester: VI
Pedagogy: lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self Problem solving to enhance comprehension		
Course Code: MCHE06	**Course Title: *Drug and API***	
Course Objectives: The objective of the course is to prepare students for varied requirements of pharmaceutical industry – R&D, manufacturing, Formulation, QC, safety audit & packaging including regulatory compliance, Clinical Research, drug discovery & development. The objectives of a **drug** are centred around **treating conditions safely and effectively**, while the **API's objectives** are focused on providing the **active therapeutic effect** with high quality, consistency, and regulatory compliance.		
Course outcome: After completing this course, the student will be able to -		

CO.1 Studying the topic "Introduction to Drugs & APIs" can be summarized in terms of gaining a foundational understanding of the roles, characteristics, and significance of drugs and active pharmaceutical ingredients (APIs) in the pharmaceutical industry.
CO.2 This unit provides students a deep understanding of the processes involved in creating new drug from the initial discovery of a potential medicinal candidate to its approval for use in the market
CO.3 The study of **Drug Safety, Pharmacovigilance, and Toxicology** empowers individuals with the knowledge to monitor and manage drug safety throughout its lifecycle. From preclinical testing to post-market surveillance, it focuses on detecting risks, preventing harm, and ensuring that drugs are safe for patient use.
C**O.4** Studying **Formulation & Drug Delivery Systems** equips individuals with the knowledge of how drugs are designed, formulated, and delivered to be most effective, safe for patients and to maximize their therapeutic effectiveness
CO.5 Hygienic Bio-Disposable Methods, Safe Handling & Pharmaceutical waste Management practices.

Credit: 3+0+0	**Paper**: Elective
Max. marks: 100(40+60)	**Min passing Marks**: 35

Total No. Of Lectures: 45+0+0

Unit	Topic	No. of lecture
Unit I	**1. Introduction to Drugs & API** • Definition and Classification of Drugs • Role of Active Pharmaceutical Ingredients (APIs) • Historical Perspective and Evolution of Pharmaceuticals • Difference Between API and Excipients	10
Unit II	**Drug Discovery & Development** • Drug Discovery Process • Preclinical and Clinical Trials • Role of AI & Machine Learning in Drug Development • Ethical Considerations & Regulatory Requirements (FDA, WHO, ICH), Algae. Biofuels: Ethanol, Biodiesel, and Next-Gen Biofuels (Cellulosic, Algal). Biogas	15
Unit- III	**Drug Safety, Pharmacovigilance & Toxicology** • Adverse Drug Reactions (ADR) & Drug-Drug Interactions • Pharmacovigilance & Post-Marketing Surveillance • Toxicological Studies & Risk Assessment.	8
Unit IV	**Formulation & Drug Delivery Systems** • Conventional vs. Novel Drug Delivery Systems • Nanotechnology in Drug Delivery • Controlled Release & Targeted Drug Delivery • Innovations in Biologics and Biosimilars	5
Unit V	**Hygienic Bio-Disposable Methods & Pharmaceutical Waste Management** • Safe Handling & Disposal of Pharmaceutical Waste • Green Pharmaceutical Practices • Biodegradable & Eco-Friendly Packaging Innovations • Wastewater Treatment in Pharma Industries	12

Suggested Readings:
1. Chemical Engineering in Pharmaceutical Industry: Active Pharmaceutical Ingredients by David J.am Ende (Amazon).
2.Active Pharmaceutical Ingredients: Development, Manufacturing & Regulations by Stanley Nusim.
3. An Introduction to Pharmaceutical Sciences: Production, Chemistry, Techniques & Technology by Jiben Roy (Barnes & Noble).

4. Martindale: The Complete Drug Reference (Wikipedia). 5. The Top 100 Drugs: Clinical Pharmacology & Practical Prescribing by Andrew Hitchings, Dagan Lonsdale, Daniel Burrage & Emma Baker. 6. https://cpcb.nic.in (Mgmt. of Healthcare waste) 7. https://pmc.ncbi.nlm.nih.gov (Introduction to essentials of Bio-medical waste) 8. https://aiims.edu (Bio-medical waste mgmt. manual) 9. https://www.slideshare.net 10. https://swachhbharatmission.ddws.gov.in 11. https://www.prepladder.com (Bio medical waste mgmt., types & coloured bins)
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

ELECTIVE (MAJOR) FOR CHEMISTRY DISCIPLINE CHOOSE ANY ONE

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VI**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23108A	**Course Title:** : Instrumental Methods of Chemical Analysis	
Course Objectives: This course aims to provide knowledge on various spectroscopic techniques for chemical analysis along with the basic principles of instrumentation.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Handle analytical data . CO.2 Understand basic components of IR, FTIR, UV-Visible and Mass spectrometer. Interpret of IR, FTIR, UV-visible spectra and their applications. CO.3 Understand the use of single and double beam instruments. CO.4 Learn separations techniques like Chromatography. CO.5 Learn elemental analysis, NMR spectroscopy, Electroanalytical Methods, Radiochemical Methods, X-ray analysis and electron spectroscopy.		
Credit: 1+0+2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 01+0+02		

Unit	Topics	No. of Lecture
Unit I	Introduction to analytical methods of data analysis Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.	3
Unit II	Molecular spectroscopy Infrared spectroscopy: Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier-Transform Infrared (FTIR)	3

	spectroscopy. Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection.	
Unit III	UV-Visible/ Near IR Spectroscopy Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags).	3
Unit IV	Separation techniques Chromatography: Gas chromatography, liquid chromatography, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques.	3
Unit V	Elemental analysis Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), wavelength separation and resolution (dependence on technique), detection of radiation (simultaneous/scanning, signal noise), interpretation (errors due to molecular and ionic species, matrix effects, other interferences).	3

Suggested Readings:

1. Stocchi, E. (1990), Industrial Chemistry, Vol-I, Ellis Horwood Ltd. UK.
2. Kent, J. A. (ed.) (1997), Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
3. Austin, G.T (2012), Shreve's Chemical Process Industries, Tata McGraw-Hill Education Private Limited.
4. Girard, J.E, (2011), Principles of Environmental Chemistry, Jones & Bartlett India Pvt. Limited.
5. Sodhi, G.S. ((2013), Fundamental Concepts of Environmental Chemistry, Narosa Publishing House. 6. Vermani, O.P; Narula, A.K. (2012), Industrial Chemistry, Galgotia Publishing Pvt. Limited.
7. Sharma, B.K. (2011), Industrial Chemistry, Goel Publishing House.
8. Pani, B. (2017), Textbook of Environmental Chemistry, I.K. International Publishing House.
9. De, A. K. (2015), Environmental Chemistry, New Age International Pvt, Ltd, New Delhi
10. Khopkar, S.M. (2012), Environmental Pollution Analysis, New Age International Publisher.

Course. prerequisite: To study this course, the students must have had subject biology in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: VI**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23112A	**Course Title: Lab work based on theory**

Course Objective: Aim to design impart understanding of experimental skill on instrumental methods of chemical analysis .

Course Outcome: After completing this course, the students will be able to -

CO1. Determine of the isoelectric pH of a protein.
CO2. Plot titration curve of an amino acid.
CO3. Potentiometric titration of a chloride-iodide mixture.
CO4: Gain experimental skill.

Credit: 0+0+2	**Paper: Elective (Major)**
Max. Marks: 100(40+60)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	**List of Practicals**	**No. of Practical (Hrs)**
	At least 5 experiments to be performed. 1. Determination of the isoelectric pH of a protein. 2. Titration curve of an amino acid. 3. Determination of the void volume of a gel filtration column. 4. Determination of a mixture of cobalt and nickel (UV-visible spectroscopy). 5. Study of electronic transitions in organic molecules (i.e., acetone in water). 6. IR absorption spectra (study of aldehydes and ketones). 7. Determination of calcium, iron, and copper in food by atomic absorption spectroscopy. 8. Quantitative analysis of mixtures by gas chromatography (i.e., chloroform and carbon tetrachloride). 9. Separation of carbohydrates by HPLC. 10. Determination of caffeine in beverages by HPLC. 11. Potentiometric titration of a chloride-iodide mixture. 12. Cyclic voltammetry of the ferrocyanide/ferricyanide couple. 13. Use of nuclear magnetic resonance instrument and to analyse the spectra of methanol and ethanol 14. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids. 15. Use of “presumptive tests” for anthrax or cocaine. 16. Collection, preservation, and control of blood evidence being used for DNA testing. 17. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome). 18. Use of sequencing for the analysis of mitochondrial DNA. 19. Laboratory analysis to confirm anthrax or cocaine.	**60**

20. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives. 21. Detection of illegal drugs or steroids in athletes. 22. Detection of pollutants or illegal dumping. 23. Fibre analysis.	
Course Prerequisite: This course can be opted as an elective by the students of Science stream in 12 th Class.	
Suggested Readings: 1. Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),Principles of Instrumental Analysis, Cengage Learning. Lab Manual	
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks	

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VI**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23108B	**Course Title:** Nanoscale Materials and Their Applications	
Course Objectives: The aim of this course is to introduce materials at nanoscale, their preparation, characterization and applications.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the concept of nanodimensions. CO.2 Know the various methods of preparation of nanomaterials. CO.3 Know the different characterization techniques used for the analysis of nanomaterials and understand the basic principle behind these techniques. CO.4 Understand the optical and conducting properties of nanostructures. CO.5 Appreciate the real life applications of nanomaterials.		
Credit: 3	**Paper: Elective (Major)**	
Max. Marks: 40+60	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 01+0+02		

Unit	**Topics**	**No. of Lecture**

Unit I	Introduction to nanodimensions 0D, 1D, 2D nanomaterials, Quantum Dots,Nanoparticles, Nanostructures (nanowires, thin films, nanorods), carbon nanostructures (carbon nanotubes, carbon nanofibers, fullerenes), Size Effects in nano systems, Quantum confinement and its consequences, Semiconductors.Band structure and band gap.	3
Unit II	Preparation of nanomaterials Top down and Bottom up approach, Photolithography. Ball milling.Vacuum deposition.Physical vapor deposition (PVD), Chemical vapor deposition (CVD), Thermal decomposition, Chemical reduction, SolGel synthesis, Hydrothermal synthesis, Spray pyrolysis,Electrochemical deposition, Pulsed Laser deposition.	3
Unit III	Characterization techniques (Basic working principles and interpretation of experimental data using these techniques need to be covered) UV-visible spectroscopy, X-ray diffraction (Powder and Single Crystal), Raman Spectroscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray Photoelectron Spectroscopy (XPS), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Dynamic light scattering (DLS), Brunauer-Emmett-Teller (BET) Surface area measurement and Thermogravimetric analysis (TG.	3
Unit IV	Optical Properties Surface plasmon resonance, Excitons in direct and indirect band gap semiconductor nanocrystals. Radiative processes: General absorption, emission and luminescence (fluorescence and photoluminescence).	3
Unit V	**Conducting properties:** Carrier transport in nanostructures. Tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. **Applications Nanomaterials:** as Catalysts, semiconductor nanomaterials as photocatalysts,Nanocomposites as catalysts. Carbon nanostructures as catalytic nanoreactors, metal and metal oxides confined inside carbon nanostructures, Nanowires and thin films for photonic devices (LEDs, solar cells, transistors).	3

Suggested Readings:

1. West, A. R.(2014),Solid State Chemistry and Its Application, Wiley
2. Smart, L. E.; Moore, E. A.(2012),Solid State Chemistry An Introduction, CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J.(1997),New Direction in Solid State Chemistry, Cambridge University Press.
4. Poole, Jr.; Charles P.; Owens, Frank J.;(2003), Introduction to Nanotechnology, John Wiley and Sons.
5. Chattopadhyay, K.K.; Banerjee, A. N.(2009),Introduction to Nanoscience and Technology, PHI.

Course prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Third year	Semester: VI

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23112B	Course Title: Lab work based on theory

Course Objective: Aim to design impart understanding of experimental skill about nanoparticles, preparation and characterisation.

Course Outcome: After completing this course, the students will be able to -

CO1. Synthesize metal nanoparticles by chemical reduction method.
CO2. Synthesize semiconductor nanoparticles.
CO3. Study surface Plasmon of metal nanoparticles by UV-Visible spectrophotometer.
CO4: Gain experimental skill.

Credit: 0+0+2	Paper: Elective (Major)
Max. Marks: 100(40+60)	Min. Passing Marks: 35

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	Topics	No. of Practical (Hrs)
	1. Synthesis of metal nanoparticles by chemical reduction method. 2. Synthesis of semiconductor nanoparticles. 3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer. 4. XRD pattern of nanomaterials and estimation of particle size. (Students can be provided with XRD patterns of known materials and asked to interpret the data.) 5. To study the effect of size on color of nanomaterials. 6. To prepare composite of CNTs with other materials. 7. Growth of quantum dots by thermal evaporation. 8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD. 9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.	**60**

Course prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Readings:

1.West, A. R.(2014),Solid State Chemistry and Its Application, Wiley
2. Smart, L. E.; Moore, E. A.(2012),Solid State Chemistry An Introduction, CRC Press Taylor & Francis.
3. Rao, C. N. R.; Gopalakrishnan, J.(1997),New Direction in Solid State Chemistry, Cambridge University Press.
4. Poole, Jr.; Charles P.; Owens, Frank J.;(2003), Introduction to Nanotechnology, John Wiley and Sons.
5. Chattopadhyay, K.K.; Banerjee, A. N.(2009),Introduction to Nanoscience and Technology, PHI.
6.Lab Manual

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VI**
Pedagogy: Lectures in class rooms, videos, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension. Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23108C	**Course Title:** IT Skills For Chemists	
Course Objectives: The objective of this course is to introduce the students to fundamental mathematical techniques and basic computer skills that will help them in solving chemistry problems. It aims to make the students understand the concept of uncertainty and error in experimental data. It acquaints the students with different software for data tabulation, calculation, graph plotting, data analysis and document preparation.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Become familiar with the use of computers. CO.2 Use software for tabulating data, plotting graphs and charts, carry out statistical analysis of the data. CO.3 Solve chemistry problems and simulate graphs. CO.4 Prepare documents that will incorporate chemical structure, chemical equations, mathematical expressions from chemistry. CO.5 Learn about water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.		
Credit: 1+0+2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

Unit	**Topics**	**No. of Lecture**
Unit I	**Mathematics Fundamentals**: mathematical functions, polynomial expressions, logarithms, the exponential function, units of a measurement, interconversion of units, constants and variables, equation of a straight line, plotting graphs. Uncertainty in experimental techniques: Displaying uncertainties, measurements in chemistry, decimal places, significant figures, combining quantities. Uncertainty in measurement: types of uncertainties, combining uncertainties. Statistical treatment. Mean, standard deviation, relative error. Data reduction and the propagation of errors. Graphical and numerical data reduction. Numerical curve fitting: the method of least squares (regression). Algebraic operations on real scalar variables (e.g. manipulation of van der Waals equation in different forms). Roots of quadratic equations analytically and iteratively (e.g. pH of a weak acid). Numerical methods of finding roots (Newton-Raphson, binary –bisection, e.g. pH of a weak acid not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions). Differential calculus: The tangent line and the derivative of a function, numerical differentiation	3

	(e.g., change in pressure for small change in volume of a van der Waals gas, potentiometric titrations). Numerical integration (Trapezoidal and Simpson's rule, e.g. entropy/enthalpy change from heat capacity data).	
Unit II	**Introductory writing activities:** Introduction to word processor and structure drawing (Chem Sketch) software. Incorporating chemical structures, chemical equations, expressions from chemistry (e.g. Maxwell-Boltzmann distribution law, Bragg's law, van der Waals equation, etc.) into word processing documents.	3
Unit III	**Handling numeric data:** Spreadsheet software (Excel/ LibreOffice Calc), creating a spreadsheet, entering and formatting information, basic functions and formulae, creating charts, tables and graphs Incorporating tables and graphs into word processing documents. Simple calculations, plotting graphs using a spreadsheet (Planck's distribution law, radial distribution curves for hydrogenic orbitals, gas kinetic theory- Maxwell-Boltzmann distribution curves as function of temperature and molecular weight), spectral data, pressure-volume curves of van der Waals gas (van der Waals isotherms), data from phase equilibria studies. Graphical solution of equations.	3
Unit IV	**Numeric modelling:** Simulation of pH metric titration curves. Excel functions LINEST and Least Squares. Numerical curve fitting, linear regression (rate constants from concentration- time data, molar extinction coefficients from absorbance data), numerical differentiation (e.g. handling data from potentiometric and pH metric titrations, pKa of weak acid), integration (e.g. entropy/enthalpy change from heat capacity data).	3
Unit V	Statistical analysis: Gaussian distribution and Errors in measurements and their effect on data sets. Descriptive statistics using Excel. Statistical significance testing: The t test. The F test. Presentation graphics.	3

1.McQuarrie, D.A. (2008), Mathematics for Physical Chemistry University Science Books.

2. Steiner, E.(2008),The Chemical Maths Book Oxford University Press.

3. Yates, P.(2007),Chemical calculations, CRC Press.

4. Harris,D.C.(2007),Quantitative Chemical Analysis. Freeman, Chapters 3-5.

5. Levie, R. de. (2001), How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge Univ. Press.

6. Venit, S.M. (1996),Programming in BASIC: Problem solving with structure and style. Jaico Publishing House.

Course prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third year**	**Semester: VI**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		

Course Code: CHE-23108C	Course Title: Lab work based on theory

Course Objective: Impart practical experience of using a spreadsheet for plotting graphs and calculation.

Course Outcome: After completing this course, the students will be able to -

CO1. Plot graphs using a spreadsheet .
CO2. Calculate using spreadsheet.
CO3. Work in Excel sheet.
CO4. Learn to calculate various parameters.

Credit: 0+0+2	Paper: Elective (Major)
Max. Marks: 100(40+60)	Min. Passing Marks:35

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	Topics	No. of Practical (Hrs)
	.1. Plotting graphs using a spreadsheet i. Planck's distribution law ii. Radial distribution curves for hydrogenic orbitals, iii. Maxwell-Boltzmann distribution curves as function of temperature and molecular weight iv. van der Waals isotherms v. Data from phase equilibria studies 2. Calculations using spreadsheet vi. Rate constants from concentration- time data vii. Molar extinction coefficients from absorbance data viii. Numerical differentiation (e.g. handling data from potentiometric and pH metric titrations) ix. pKa of weak acid 3. Preparing a word processing document having tables, chemical structures and chemical equations	**60**

Course prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Readings:

1. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),Introduction to organic Laboratory TechniqueA Microscale approach,4th Edition, Brrooks-Cole Laboratory Series for Organic chemistry.
4. Sharma R. K., Sharma, C., & Sidhwani, I.T. Solventless and one-pot synthesis of Cu(II) phthalocyanine complex: a green chemistry experiment. Journal of Chemical Education, 2010, 88(1), 86-88.
5. Sharma, R. K., Gulati, S., & Mehta, S. Preparation of gold nanoparticles using tea: a green chemistry experiment. Journal of Chemical Education, 2012, 89(10), 1316-1318.
6. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A social Awareness Project" Indu Tucker Sidhwani, Geeta Saini, Sushmita Chowdhury, Dimple Garg, Malovika, Nidhi Garg, Delhi University Journal of Undergraduate Research and Innovation, Vol 1, Issue 1, Feb 2015. ISSN: 2395-23344.
7.Lab Manual

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Other Courses:

Minor : To be Choosed from POOL B
Skill Enhancement Course (SEC) : To be Choosed from POOL C
Value Added Course (VAC): To be Choosed from POOL D

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Exit Option: Bachelor Degree (Programme duration: Three years or six semesters).
[NHEQF Level 5.5]

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SEMESTER-VII

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourt Year**	**Semester: VII**
Pedagogy: Lectures in class rooms, Hands-on learning using 3-D models, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Course Code: CHE-23110	**Course Title: Chemistry of Biomolecules**	
Course Objectives: This core course aims to introduce the learner to the fascinating chemistry of some biomolecules,i.e., amino acids, peptides, proteins, carbohydrates, lipids and nucleic acids that work within biological systems. It aims to build the concept of metabolism by the study of chemistry and energetics of biological system.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand and demonstrate how structure of biomolecules determines their reactivity and biological functions. CO.2 Gain insight into concepts of heredity through the study of genetic code, replication, transcription and translation. CO.3 Demonstrate understanding of metabolic pathways, their inter-relationship, regulation and energy production from biochemical processes. CO.4. Understand biological importance of Carbohydrates and lipids CO.5 Understand the Concept of Energy in Biosystems.		
Credits: 3+0+2	Paper: Core Compulsory	

Max. Marks: 40+60 (30T+30P)	Min. Passing Marks: 35	
Total Number of Lectures (Lecture + Practical + Tutorial): 45 + 0 + 60		
Unit	**Topics**	No. of Lectures
Unit I	**Nucleic Acids:** Structure of components of nucleic acids: Bases, Sugars, Nucleosides and Nucleotides. Nomenclature of nucleosides and nucleotides, structure of polynucleotides (DNA and RNA), concept of DNA duplex formation and its characterization. Biological roles of DNA and RNA. Concept of heredity:Genetic Code, Replication, Transcription and Translation.	9
Unit II	**Amino Acids:** Peptides and Proteins Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, pKa values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structure-end group analysis. Synthesis of peptides using N-protecting, C-protecting and Cactivating groups, Solid-phase synthesis; primary, secondary and tertiary structures of proteins, Denaturation of proteins.	9
Unit III	**Enzymes**: Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking chymotrypsin as an example), factors affecting enzyme action, coenzymes and cofactors (NAD,FAD), specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance..	9
Unit IV	**Carbohydrates and lipids:** Occurrence, classification and their biological importance. Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projection and conformational structures; Interconversion of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen. Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.	9
Unit V	**Concept of Energy in Biosystems:** Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+ , FAD. Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle. Caloric value of food, standard caloric content of food types.	9

Suggested Readings:

1. Berg, J.M.; Tymoczko, J.L.; Stryer, L. (2006),Biochemistry. W.H. Freeman and Co.
2. Nelson, D.L.; Cox, M.M.; Lehninger, A.L.(2009),Principles of Biochemistry. W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A.; Rodwell, V.W.(2009),Harper's Illustrated Biochemistry.Lange Medical Books/McGraw-Hill.
4. Brown,T.A. (2018) Biochemistry, (First Indian addition 2018) Viva
5.Books.Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx.
6.https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have had science stream in class 12th .

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VII**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23110	**Course Title: Lab work based on theory**

Course Outcome: After completing this course, the students will be able to -

CO1. Separate amino acids by paper chromatography.
CO2. Estimate proteins by Lowry's method.
CO3. Action of salivary amylase on starch.
CO4: Understand working protocols related to various instrumental techniques.

Credit: 0+0+2	**Paper: Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	**Topics**	**No. of Practical (Hrs)**
	1. Separation of amino acids by paper chromatography 2. Study of titration curve of glycine and determination of its isoelectric point. 3. Estimation of proteins by Lowry's method 4. Action of salivary amylase on starch 5. Effect of temperature on the action of salivary amylase on starch. 6. To determine the saponification value of an oil/fat. 7. To determine the iodine value of an oil/fat	**60**

8. Qualitative tests for carbohydrates- Molisch test Barfoed's reagent test, rapid furfural test,Tollen's test and Fehling solution test(Only these tests are to be done in class) 9. Qualitative tests for proteins 10. Extraction of DNA from onion/cauliflower	

Suggested Readings:

1 Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012),Vogel's Textbook ofPractical Organic Chemistry, Pearson.
2. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi
3.Lab Manual

Course prerequisite: To study this course, the students must have had science stream in class 12th.

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks.

Minor paper [For Students of other Discipline/Subject]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: B.Sc. 3rd Year	Semester: VII
Pedagogy: lectures in classroom, videos, presentation Transaction through an intelligent mix of conventional and digital (ICT) methods, engaging students in cooperative learning, learning through quiz & GD, Self Problem solving to enhance comprehension.		
Course Code: MCHE07	**Course Title: Chemistry in Real World**	

Objective of course: The objective of showing & examining "Chemistry in the Real World" is to explore the practical applications of chemical concepts in daily life and diverse industries. This topic aims to illustrate how chemical reactions and processes are integral to every sphere of daily life especially healthcare, food production, **applied chemistry** and **industrial chemistry**. By examining real-life examples, the objective is to show the significant impact of chemistry on solving problems, improving living conditions, and advancing innovation. The goal is to foster an understanding of how chemistry influences and enhances various aspects of society, making it a critical field for progress and sustainability.

Course outcome: After completing this course, the student will be able to -

CO.1 Exploring the topic of beverages from a scientific standpoint leads to several valuable outcomes, particularly in understanding their composition, production processes, and effects.

CO.2 The study of food additives, adulterants, and contaminants leads to a better understanding of their roles and impacts on food safety and quality. Key outcomes include Awareness of Food Additives, Identification of Adulterants Detection of Contaminants, Regulatory and Safety Measures.

CO.3 The study of artificial sweeteners, flavours, and food colorants leads to a deeper understanding of their roles in modern food processing and their effects on health, safety, and consumer choices.

CO.4 The study of paints and pigments leads to a better understanding of their composition, uses, and effects. Key outcomes include Chemical Composition, Types of Pigments, Applications, Environmental and Health Impacts.

CO.5 The study of dyes & Fertilizers provides valuable insights into their chemical properties, applications, and impact. Key outcomes include Chemical Properties of Dyes, Types of Dyes, Applications and Industries.

Credit: 3	**Paper**: Elective
Max. marks: 100(40+60)	**Min passing Marks**: 35

Total No. Of Lectures: 45+0+0

Unit	Topic	No. of lecture
Unit I	**Beverages:** Analysis of caffeine in coffee and tea, detection of chicory in coffee, chloral hydrate in toddy, estimation of methyl alcohol in alcoholic beverages.	10
Unit II	**Food additives, adulterants and contaminants**- Food preservatives like benzoates, propionates, sorbates, disulphites.	15
Unit-III	**Artificial sweeteners:** Aspartame, saccharin, dulcin, sucralose and sodium cyclamate. **Flavours:** Vanillin, alkyl esters (fruit flavours) and monosodium glutamate. **Artificial food colorants**: Coal tar dyes and non-permitted colours and metallic salts. Analysis of pesticide residues in food.	8
Unit IV	**Paints & Pigments:** White pigments (white lead, ZnO, lithopone, TiO2). Blue, red, yellow and green pigments. Paints and distempers: Requirement of a good paint. Emulsion, latex; luminescent paints. Fire retardant paints and enamels, lacquers. Solvents and thinners for paints.	5
Unit V	**Fertilizers & Dyes:** Colour and constitution (electronic concept). Classification of dyes. Methods of applying dyes to the fabrics. A general study of azo dyes, Mordant brown, Congo red and methyl orange. A introduction to fertilizers, type, importance & essential nutrients.	7

Suggested Readings:

1. Chemistry in Every day's Life by Sanjay Roy (Amazon).
2. Chemistry in Daily Life by Kirpal Singh (Google books).
3. Chemistry in Everyday Life by Jeyaraj Prabhu (Barnes & Noble).
4. Chemistry in Everyday Life by Michele Lansigan (Open Access resource).
5. Chemistry for Breakfast: The Amazing Science of Everyday Life by Mai Thi Nguyen-Kim
6. https://www.britannica.com (fertilizers); https://www.researchgate.net (A textbook of fertilizers); https://extension.oregonstate.edu (A guide to understanding fertilizers)
7. https://slideshare.net (Fertilizer introduction PPT); https://oercommons.org (intro to fertilizers)

Course prerequisite: To study this course, the students must have had science stream in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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[For Students Pursuing Hons. With Research]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VII**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Subject: CHEMISTRY		
Course Code: CHE-23111A	**Course Title: Research Methodology for Chemistry**	
Course Outcome: After completing this course, the students will be able to -		
CO.1 Learn how to identify research problems. CO2. Evaluate local resources and need for addressing the research problem CO3. Find out local solution. CO4. Know how to communicate the research findings. CO5. Know the biostatistics and exposure of chemistry software.		
Credit: 4	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 60+0+0		

Unit	Topics	No. of Lecture
Unit I	**Literature Survey:** **Print-** Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. **Digital-** Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information. Open source Lead lectures. Open source chemistry designing sources, Essentials of Problem formulation and communication with society.	15
Unit II	**Methods of Scientific Research and Writing Scientific Papers**: Reporting practical and project work. Idea about public funding agencies of research, Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism. Assessment of locally available resources.	15
Unit III	**Chemical Safety and Ethical Handling of Chemicals**:	10

	Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric level. Safe storage and disposal of waste chemicals. Recovery, recycling and reuse of laboratory chemicals. Procedure for laboratory disposal of explosives. Identification, verification and segregation of laboratory waste. Disposal of chemicals in the sanitary sewer system. Incineration and transportation of hazardous chemicals.	
Unit IV	**Data Analysis:** The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments. Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.	10
Unit V	**Biostatistics and Exposure of Chemistry software:** brief introduction and data handling. software Chemistry Students must be given exposure to applications of molecular modelling softwares e.g. Hyperchem, Schrodinger etc. Hands on experiments of docking.	10

Suggested Readings:

1. Dean, J.R.; Jones, A.M.; Holmes, D;, Reed, R.; Jones, A.Weyers, J. (2011),Practical skills in chemistry, Prentice-Hall.
2. Hibbert, D.B.; Gooding, J.J. (2006),Data analysis for chemistry, Oxford University Press.
3. Topping, J.(1984),Errors of observation and their treatment, Chapman Hall, London
4. Levie, R. de.(2001),How to use Excel in analytical chemistry and in general scientific data analysis, Cambridge University Press.
5. Le, C.T.; Eberly,L.E. (2016),Introductory Biostatistics, Wiley.
6. Chemical safety matters IUPAC – IPCS, Cambridge University Press, 1992.
7. OSU safety manual 1.01.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[For Students Pursuing Honours Only]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Third Year	Semester: VII
Pedagogy: Lectures in class rooms, videos, presentations, Teaching Learning Process for the course is visualized as largely student-focused, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: CHEMISTRY		
Course Code: CHE-23112B	**Course Title: Pharmaceutical Chemistry**	
Course Objectives: The objective of this paper is to develop basic understanding of drugs discovery, design, development and their side effects. The course will cover synthesis of major drug classes including-analgesics, antipyretics, anti- inflammatory agents, antibacterial and antifungal agents, antiviral agents, central nervous system agents and drugs for HIV--AIDS. An overview of fermentation process and production of certain dietary supplements and certain common antibiotics will be discussed.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Gain insight into retro-synthesis approach in relation to drug design and drug discovery CO2. Learn synthetic pathways of major drug classes. CO3. Understand the fermentation process and production of ethanol, citric acids, antibiotics and some classes of vitamins. CO4. Learn Antineoplastic Agents. CO5. Explain Cardiovascular Drugs .		
Credit: 02+00+02	**Paper: Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+60		

Unit	Topics	No. of Lecture
Unit I	**Drug discovery, design Pharmaceutical Compounds and development:** Classification, structure and therapeutic uses of antipyretics - Paracetamol (with synthesis), Analgesics Ibuprofen (with synthesis); Antimalarials - Chloroquine (with synthesis); Antitubercular drugs - Isoniazid. An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine). Sources of drugs: biological, marine, minerals and plant tissue culture, physio-chemical aspects (optical, geometric and bioisosterism) of drug molecules and biological action, drug receptor interaction, basic retro-synthetic approach for development of drug. Cause of side effect of drugs like ibuprofen, cetirizine, thalidomide. Difference between drug and poison.	6
Unit II	**Drugs and Pharmaceuticals**: Study of pharmaceutical aids like talc, diatomite, kaolin, bentomite, gelatin and natural colours Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, antiinflammatory agents (Aspirin); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), central nervous system agents (Phenobarbital, Diazepam),Cardiovascular (Glyceryl trinitrate), antilaprosy (Dapsone), HIV-AIDS related drugs (AZT- Zidovudine).	6
Unit III	**Fermentation**: Aerobic and anaerobic fermentation. Production of (i) Ethyl alcohol and citric acid, (ii) Antibiotics; Penicillin, Cephalosporin, Chloromycetin and Streptomycin, (iii) Lysine, Glutamic acid, Vitamin B2, Vitamin B12 and Vitamin C.	6

Unit IV	**Relationship of chemical structure and biological activities and theories of drug action**: Detailed study of following classes: Antineoplastic Agents: Introduction, cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer. Mention of carcinolytic antibiotics and mitoptic inhibitors. Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, amustards, and 6- mercaptopurine products.	6
Unit V	**Cardiovascular Drugs:** Cardiovascular diseases, drug inhibition of peripheral sympathetic function. Direct acting arteriolar dilators. Synthesis of amyl nitrate, hydralaxine, verapamil, methyldopa and diazoxide propanol.	6

Suggested Readings:

1.Patrick, G. (2017), Introduction to Medicinal Chemistry, Oxford University Press.

2. Singh H.; Kapoor V.K. (1996), Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan.

3. Foye, W.O.; Lemke, T. L.; William, D.A. (1995),Principles of Medicinal Chemistry, B.I. Waverly Pvt. Ltd.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VII**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23111B	**Course Title: Lab work based on theory**

Course Outcome: After completing this course, the students will be able to -

CO1. Prepare and analyse Aspirin.
CO2. Prepare paracetamol.
CO3. Prepare and analyse sulphacetamide.
CO4: Understand working protocols related to various instrumental techniques.

Credit: 0+0+2	**Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 2

Unit	Topics	No. of Practical (Hrs)

1.Preparation of aspirin and its analysis. 2. Preparation of paracetamol and its analysis. 3. Preparation of sulphacetamide of sulphonamide and its analysis. 4. Determination of alcohol contents in liquid drugs/galenical. 5. Determination of ascorbic acid in vitamin C tablets by iodometric or coulometric titrations. 6. Synthesis of ibuprofen. 7. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry.	**60**

Suggested Readings:

1 Kjonaas, R.A.; Williams, P.E.; Counce, D.A.; Crawley, L.R. Synthesis of Ibuprofen. J. Chem. Educ., 2011, 88 (6), pp 825–828 DOI: 10.1021/ed100892p.
2. Marsh, D.G.; Jacobs, D.L.; Veening, H. Analysis of commercial vitamin C tablets by iodometric and coulometric titrimetry. J. Chem. Educ., 1973, 50 (9), p 626. DOI: 10.1021/ed050p626
3.Lab Manual

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

ELCTIVE (MAJOR) FOR CHEMISTRY DISCIPLINE CHOOSE ANY TWO

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VII**
Pedagogy: Lectures in class rooms, Hands-on learning using 3-D models, videos, presentations, Teaching Learning Process for the course is visualized as largely student-focused, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23112A	**Course Title:** Basic Analytical Chemistry	
Course Objectives: The objective of this course is to make students aware about the importance and the concepts of chemical analysis of water and soil, using separation techniques like chromatography and instrumentation techniques like flame photometry and spectrophotometry.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Handle analytical data. CO.2 Determine composition and pH of soil, which can be useful in agriculture. CO.3 Do quantitative analysis of metal ions in water. CO.4 Separate mixtures using separation techniques. CO.5 Estimate macro nutrients using Flame photometry.		
Credit: 2+0+2	**Paper: Elective (Major)**	
Max. Marks: 100(40+60)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+60		

Unit	Topics	No. of Lecture
Unit I	**Introduction**: Introduction to analytical chemistry and its interdisciplinary nature, Concept of sampling. Importance of accuracy, precision and sources	6

	of error in analytical measurements. Significant figures. Presentation of experimental data and results.	
Unit II	**Analysis of soil**: Composition of soil, concept of pH and its measurement, complexometric titrations, chelation, chelating agents, use of indicators.	6
Unit III	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.	6
Unit IV	**Chromatography** Definition and general introduction on principles of chromatography. Paper chromatography, thin layer chromatography, Column chromatography and ion-exchange chromatography.	6
Unit V	**Environment:** Water Quality Standards and Water pollution: Water quality parameters like pH, alkalinity, DO, BOD, COD, chloride, sulphate, available chlorine etc.	6

Suggested Readings:

1. Christian, G.D. (2004),Analytical Chemistry, John Wiley & Sons.
2. Harris, D. C. (2007),Exploring Chemical Analysis, W.H. Freeman and Co.
3. Skoog, D.A.; Holler F.J.; Nieman, T.A. (2005),Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd.
4. Svehla, G. (1996),Vogel's Qualitative Inorganic Analysis, Prentice Hall.
5. Mendham, J.; Denney, R.C.; Barnes, J.D.; Thomas, M.J.K. (2007), Vogel's Quantitative Chemical Analysis,6th Edition, Prentice Hall.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VII**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23112A	**Course Title: Lab work based on theory**	
Course Objective: Impart hands on experience of measuring pH, acidity, DO metal ions of the given sample.		
Course Outcome: After completing this course, the students will be able to -		
CO1. Determination of pH of soil samples. CO2. Determination of pH, acidity and alkalinity of a water sample CO3. To study the use of phenolphthalein in trap cases. CO4. Learn safety rules in the practice of laboratory investigation.		
Credit: 0+0+2	**Paper: Elective (Major)**	

Max. Marks: 40+60 (30T+30P)		Min. Passing Marks: 35
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60		
Unit	**Topics**	**No. of Practical (Hrs)**
	1. Determination of pH of soil samples. 2. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration. 3. Determination of pH, acidity and alkalinity of a water sample. 4. Determination of dissolved oxygen (DO) of a water sample. 5. Paper chromatographic separation of mixture of metal ion (Ni^{2+} and Co^{2+}). 6. To study the use of phenolphthalein in trap cases. 7. To analyze arson accelerants. 8. To carry out analysis of gasoline. 9. Estimation of macro-nutrients: Potassium, calcium and magnesium in soil samples by flame photometry. 10. Spectrophotometric determination of Iron in vitamin / dietary tablets. 11. Spectrophotometric identification and determination of caffeine and benzoic acid in soft drink. 12. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).	**60**

Suggested Readings:

1. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),Introduction to organic Laboratory TechniqueA Microscale approach,4th Edition, Brrooks-Cole Laboratory Series for Organic chemistry.
4. Sharma R. K., Sharma, C., & Sidhwani, I.T. Solventless and one-pot synthesis of Cu(II) phthalocyanine complex: a green chemistry experiment. Journal of Chemical Education, 2010, 88(1), 86-88.
5. Sharma, R. K., Gulati, S., & Mehta, S. Preparation of gold nanoparticles using tea: a green chemistry experiment. Journal of Chemical Education, 2012, 89(10), 1316-1318.
6. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A social Awareness Project" Indu Tucker Sidhwani, Geeta Saini, Sushmita Chowdhury, Dimple Garg, Malovika, Nidhi Garg, Delhi University Journal of Undergraduate Research and Innovation, Vol 1, Issue 1, Feb 2015. ISSN: 2395-23344.
7.Lab Manual

Course prerequisite: To study this course, the students must have had science stream in class 12th.

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: Third Year	Semester: VII
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, ,Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23112B		**Course Title:** Green Methods in Chemistry
Course Objectives: Today's society is moving towards becoming more and more environmentally conscious. There is rising concern of environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up, legislation which is getting stringent with strict environmental laws, rising cost of waste deposits and so on. We are faced with a challenge to work towards sustainable practices. Green chemistry has arisen from these concerns. It is not a new branch of chemistry but the way chemistry should be practiced. Innovations and applications of green chemistry in education has helped companies not only gain environmental benefits but at the same time achieve economic and societal goals also. This is possible because these undergraduate students are ultimate scientific community of tomorrow.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the twelve principles of green chemistry and will build the basic understanding of toxicity, hazard and risk of chemical substances. CO.2 Understand stoichiometric calculations and relate them to green chemistry metrics. They will learn about atom economy and how it is different from percentage yield. CO.3 Learn to design safer chemical, products and processes that are less toxic, than current alternatives. Hence, they will understand the meaning of inherently safer design for accident prevention and the principle "what you don't have can't harm you" CO.4 Understand benefits of use of catalyst and bio catalyst, use of renewable feed stock which helps in energy efficiency and protection of the environment, renewable energy sources, importance led reactions in various green solvents. CO.5 Appreciate the use of green chemistry in problem solving skills, critical thinking and valuable skills to innovate and find out solution to environmental problems. Thus, the students are able to realise that chemistry can be used to solve rather than cause environmental problems.		
Credit: 02+00+02		**Paper: Elective (Major)**
Max. Marks: 40+60 (30T+30P)		**Min Passing Marks: 35**
Total Number of Lectures (Lecture +Tutorials + Practical): 30+0+60		

++Unit	Topics	No. of Lecture
Unit I	**Introduction to Green Chemistry**: What is Green Chemistry? Some important environmental laws, pollution prevention Act of 1990, emergence of green chemistry, Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry	6
Unit II	**Principles of Green Chemistry and Designing a Chemical synthesis**: Twelve principles of Green Chemistry and their explanation with examples Special emphasis on the following: • Prevention of Waste/ by products; maximum incorporation of the materials used in the process into the final products , Environmental impact factor, waste or pollution prevention hierarchy • Green metrics to assess greenness of a reaction, e.g. Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. • Prevention/ minimization of hazardous/ toxic products reducing toxicity • Risk = (function) hazard x exposure	9

	• Designing safer chemicals with minimum toxicity yet has the ability to perform the desired functions • Green solvents: super critical fluids with special reference to carbon dioxide, water as a solvent for organic reactions, ionic liquids, fluorous biphasic solvent, PEG, solventless processes, solvents obtained from renewable resources and how to compare greenness of solvents • Energy requirements for reactions – alternative sources of energy: use of microwaves , ultrasonic energy and photochemical energy • Selection of starting materials; should be renewable rather than depleting, Illustrate with few examples such as biodiesel and polymers from renewable resources (such as green plastic) • Avoidance of unnecessary derivatization – careful use of blocking/protecting groups • Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis. Design for degradation: A product should not persist after the commercial function is over e.g. soaps and detergents, pesticides and polymers • Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes. • Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.	
Unit III	**Examples of Green Synthesis/ Reactions**: • Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis). • Green Reagents: Non-phosgene Isocyanate Synthesis, Selective Methylation using dimethylcarbonate. • Microwave assisted solvent free synthesis of copper phthalocyanine • Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid and Decarboxylation reaction • Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)	6
Unit IV	**Real world case studies based on the Presidential green chemistry awards of EPA** • Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments. • A new generation of environmentally advanced wood preservatives: Getting the chromium and Arsenic out of pressure treated wood. • An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn. • Healthier Fats and oils by Green Chemistry: Enzymatic Inter esterification for production of No Trans-Fats and Oils. • Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting. • Using a naturally occurring protein to stimulate plant growth, improve crop quality, increase yields, and suppress disease.	6
Unit V	**Future Trends in Green Chemistry**: Oxidation reagents and catalysts; Biomimcry and green chemistry, Biomimetic, Multifunctional Reagents; mechanochemical and solvent free synthesis of	3

	inorganic complexes; co crystal controlled solid state synthesis (C2S 3); Green chemistry in sustainable development.	

Suggested Readings:

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

2. Lancaster, M.(2016),Green Chemistry An Introductory Text.2nd Edition, RSC Publishing.

3. Cann , M. C. ;Connely,M. E.(2000), Real-World cases in Green Chemistry, American Chemical Society, Washington.

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

5. Alhuwalia,V. K.; Kidwai, M.R.(2005),New Trends in Green chemistry, Anamalaya Publishers.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VII**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23112B	**Course Title: Lab work based on theory**

Course Objective: Aim to design impart understanding of experimental skill about nanoparticles, biodiesel preparation and characterisation.

Course Outcome: After completing this course, the students will be able to -

CO1. Prepare and characterize nanoparticles .
CO2. Prepare and characterize biodiesel from vegetable oil
CO3. Design and conduct an experiment by utilizing the products and by-products.
CO4: Gain experimental skill.

Credit: 0+0+2	**Paper: Elective (Major)**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

Unit	**List of Practicals**	**No. of Practical (Hrs)**
	Characterization by m. pt.; U.V.-Visible spectroscopy, IR spectroscopy, and any other specific method should be done (wherever applicable). 1. Preparation and characterization of nanoparticles of gold using tea leaves/ silver nanoparticles using plant extracts. 2. Preparation and characterization of biodiesel from vegetable oil preferably waste cooking oil. 3. Extraction of D-limonene from orange peel using liquid CO2 prepared from dry ice. 4. Mechanochemical solvent free, solid-solid synthesis of azomethine using p-toluidine and o-vanillin (various other combinations of primary amine and aldehyde can also be tried). 5. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper(II). 6. Designing and conducting an experiment by utilizing the products and by-products obtained in above preparations which become waste otherwise if not used. This is done by critical thinking and literature survey. Some representative examples:	**60**

7. Use of nanoparticles as catalyst for a reaction. 8. Use of azomethine for complex formation. 9. Conversion of byproduct of biodiesel to a useful product.	

Suggested Readings:

1. Kirchoff, M.; Ryan, M.A. (2002), Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K.(2013), Green Chemistry Experiments: A monograph, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia,D.L.; Lamponam, G.H.; Kriz, G.S.W. B.(2006),Introduction to organic Laboratory TechniqueA Microscale approach,4th Edition, Brrooks-Cole Laboratory Series for Organic chemistry.
4. Sharma R. K., Sharma, C., & Sidhwani, I.T. Solventless and one-pot synthesis of Cu(II) phthalocyanine complex: a green chemistry experiment. Journal of Chemical Education, 2010, 88(1), 86-88.
5. Sharma, R. K., Gulati, S., & Mehta, S. Preparation of gold nanoparticles using tea: a green chemistry experiment. Journal of Chemical Education, 2012, 89(10), 1316-1318.
6. Wealth from waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated "A social Awareness Project" Indu Tucker Sidhwani, Geeta Saini, Sushmita Chowdhury, Dimple Garg, Malovika, Nidhi Garg, Delhi University Journal of Undergraduate Research and Innovation, Vol 1, Issue 1, Feb 2015. ISSN: 2395-23344.
7.Lab Manual

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VII**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23112C	**Course Title:** Chemical Technology and Society	
Course Objectives: This course will help students to connect chemical technology for societal benefits. It would fulfil the gap between academia and industries.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand the use of basic chemistry to chemical engineering. CO.2 Learn and use various chemical technology used in industries. CO.3 Develop scientific solutions for societal needs. CO.4 Learn about air pollution, air pollutants, their control procedure, global warming, ozone depletion. CO.5 Learn about water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.		
Credit: 04+0+0	**Paper: Elective (Major)**	
Max. Marks: 40+60	**Min Passing Marks: 35**	

Total Number of Lectures (Lecture +Tutorials + Practical): 60+0+0		
++Unit	**Topics**	**No. of Lecture**
Unit I	**Chemical Technology:** Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption. An introduction into the scope of different types of equipment needed in chemical technology, including reactors, distillation columns, extruders, pumps, mills, emulgators. Scaling up operations in chemical industry. Introduction to clean technology.	12
Unit II	**Society:** Exploration of societal and technological issues from a chemical perspective. Chemical and scientific literacy as a means to better understand topics like air and water (and the trace materials found in them that are referred to as pollutants).	12
Unit III	**Sources of energy:** Coal, petrol and natural gas. Nuclear fusion / fission, solar, hydrogen, geothermal, tidal and hydel.	12
Unit IV	**Properties of Polymers (Physical, thermal, Flow & Mechanical Properties)** Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphide), polypyrrole, polythiophene].	12
Unit V	Natural Polymers Structure, properties and applications of shellac, lignin, starch, nucleic acids and proteins. Basics of drug synthesis Application of genetic engineering	12
Suggested Readings: 1. Hill, J.W.; McCreary, T.W.; Kolb, D.K. (2013),Chemistry for changing times, Pearson		
Course. prerequisite: To study this course, the students must have had science stream in class 12th		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

SEMESTER-VIII

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth Year**	**Semester: VIII**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Course Code: CHE-23113	**Course Title: Spectroscopy**	
Course Objectives: The aim of this course is to make students understand the basis of molecular spectroscopy, separation technique, elemental analysis and its applications		

Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand and solve the conceptual questions using knowledge by studying the models of atom, quantum numbers, electronic configuration, shapes of orbitals Schrodinger wave equation and significance of wave function. Understand different types of chemical bonding Gain knowledge on Hybridization, Hyperconjugation, and Inductive effects. **CO.2** Understand the classification of elements, periodicity of atomic properties and general principles of extraction and purification of metals. **CO.3** Draw the plausible structures and geometries of molecules using, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules). . **CO.4.** Explain double salts and coordination compounds, ligands. Isomerism in coordination compounds, stereochemistry ofcomplexes **CO.5** Understand the mechanism of organic reactions.		
Credits: 3+0+2	**Paper: Core Compulsory**	
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**	
Total Number of Lectures (Lecture + Practical + Tutorial): 45 + 0 + 60		
Unit	**Topics**	No. of Lectures
Unit I	Introduction to analytical methods of data analysis Treatment of analytical data, including error analysis. Classification of analytical methods and the types of instrumental methods. Consideration of electromagnetic radiations.	10
Unit II	**Infrared spectroscopy:** Interaction of radiations with molecules: absorption and scattering. Means of excitation (light sources), separation of spectrum (wavelength dispersion, time resolution), detection of the signal (heat, differential detection), interpretation of spectrum (qualitative, mixtures, resolution), advantages of Fourier-Transform Infrared (FTIR) spectroscopy. Applications: Issues of quality assurance and quality control, special problems for portable instrumentation and rapid detection.	08
Unit III	**UV-Visible/ Near IR Spectroscopy**: Emission, absorption, fluorescence and photoacoustic. Excitation sources (lasers, time resolution), wavelength dispersion (gratings, prisms, interference filters, laser, placement of sample relative to dispersion, resolution), Detection of signal (photocells, photomultipliers, diode arrays, sensitivity and S/N), Single and double beam instruments, Interpretation (quantification, mixtures, absorption vs. fluorescence and the use of time, photoacoustic, fluorescent tags). **Mass spectroscopy** Making the gaseous molecule into an ion (electron impact, chemical ionization), Making liquids and solids into ions (electrospray, electrical discharge, laser desorption, fast atom bombardment), Separation of ions on basis of mass to charge ratio, Magnetic, Time of flight, Electric quadrupole. Resolution, time and multiple separations, detection and interpretation	10

Unit IV	**Separation techniques**: Chromatography: Gas chromatography, liquid chromatography, Importance of column technology (packing, capillaries), Separation based on increasing number of factors (volatility, solubility, interactions with stationary phase, size, electrical field), Detection: simple vs. specific (gas and liquid), Detection as a means of further analysis (use of tags and coupling to IR and MS), Electrophoresis (plates and capillary) and use with DNA analysis. Immunoassays and DNA techniques.	10
Unit V	**Elemental analysis**: Mass spectrometry (electrical discharges). Atomic spectroscopy: Atomic absorption, atomic emission, and atomic fluorescence. Excitation and getting sample into gas phase (flames, electrical discharges, plasmas), wavelength separation and resolution (dependence on technique), detection of radiation (simultaneous/scanning, signal noise), interpretation (errors due to molecular and ionic species, matrix effects, other interferences). **NMR spectroscopy:** Principle, Instrumentation, Factors affecting chemical shift, Spin-coupling, Applications. **Electroanalytical Methods:** Potentiometry & Voltammetry. **Radiochemical Methods:** X-ray analysis and electron spectroscopy (surface analysis).	07

Suggested Readings:

1. Willard, H.H.; Merritt, L.L. Jr.; Dean, J.A.; Settle, F.A. Jr.(2004), Instrumental methods of analysis, 7th edition, CBS Publishers.
2. Christian, G.D.(2004),Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
3. Skoog, D.A.; Holler, F. J.; Crouch, S.(2006),Principles of Instrumental Analysis, Thomson Brooks/Cole.
4. Banwell, C.N. (2006),Fundamentals of Molecular Spectroscopy,Tata McGraw-Hill Education
5. Suggested online links: http://heecontent.upsdc.gov.in/Home.aspx
6.https://nptel.ac.in/courses/104/106/104106096/

Course prerequisite: To study this course, the students must have had science stream in class 12^{th} .

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VIII**
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23113	**Course Title: Lab work based on theory**	
Course Objectives: Utilize the fundamental laboratory techniques for analyse isoelectric pH, separation techniques.		

Course Outcome: After completing this course, the students will be able to -

CO1. Determine isoelectric pH, void volume, mixture of cobalt and nickle etc.
CO2. Have understanding of separation techniques.
CO3. Familiar with basic laboratory apparatus/equipments .
CO4: Understand working protocols related to various instrumental techniquess.

Credit: 0+0+2	**Compulsory**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks:35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

List of Practicals	**No. of Practical (Hrs)**
At least 10 experiments to be performed. 1. Determination of the isoelectric pH of a protein. 2. Titration curve of an amino acid. 3. Determination of the void volume of a gel filtration column. 4. Determination of a mixture of cobalt and nickel (UV-visible spectroscopy). 5. Study of electronic transitions in organic molecules (i.e., acetone in water). 6. IR absorption spectra (study of aldehydes and ketones). 7. Determination of calcium, iron, and copper in food by atomic absorption spectroscopy. 8. Quantitative analysis of mixtures by gas chromatography (i.e., chloroform and carbon tetrachloride). 9. Separation of carbohydrates by HPLC. 10. Determination of caffeine in beverages by HPLC. 11. Potentiometric titration of a chloride-iodide mixture. 12. Cyclic voltammetry of the ferrocyanide/ferricyanide couple. 13. Use of nuclear magnetic resonance instrument and to analyse the spectra of methanol and ethanol 14. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids. 15. Use of “presumptive tests” for anthrax or cocaine. 16. Collection, preservation, and control of blood evidence being used for DNA testing. 17. Use of capillary electrophoresis with laser fluorescence detection for nuclear DNA (Y chromosome only or multiple chromosome). 18. Use of sequencing for the analysis of mitochondrial DNA. 19. Laboratory analysis to confirm anthrax or cocaine. 20. Detection in the field and confirmation in the laboratory of flammable accelerants or explosives. 21. Detection of illegal drugs or steroids in athletes. 22. Detection of pollutants or illegal dumping. 23. Fibre analysis.	**60**

Suggested Readings:

1.Skoog, D. A.; Holler, F. J.; Crouch, S.(2006),Principles of Instrumental Analysis, Cengage Learning.
2.Lab Manual

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks

Attendance/Behavior – 05 Marks

EIECTIVE (MAJOR) FOR CHEMISTRY DISCIPLINE CHOOSE ANY ONE

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VIII**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Learning through quiz design, ,Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23114A	**Course Title: Fuel Chemistry**	
Course Objectives: Objectives: The course aims to provide students with a basic scientific and technical understanding of the production, behaviour and handling of hydrocarbon fuels and lubricants, including emerging alternative & renewable fuels. This will enable them to be industry ready to contribute effectively in the field of petroleum chemistry and technology.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 The course covers both conventional petroleum-based fuels, and alternative & renewable fuels, including gaseous fuels **CO.2** The students will learn the chemistry that underpins petroleum fuel technology, will understand the refining processes used to produce fuels and lubricants and will know how differences in chemical composition affect properties of fuels and their usage in different applications. **CO.3.** The course will also cover fuel product specifications, various test methods used to qualify different types of fuels as well characterization methods. **CO.4** The course will also cover origin of petroleum, crude oil, composition, different refining processes employed industrially to obtain different fractions of petroleum. Further, course will cover various alternative and renewable fuels like Biofuels (Different generations), Gaseous Fuels (e.g. CNG, LNG, CBG, Hydrogen etc.). **CO.5** Review of energy scenario (Global & India), Energy sources (renewable and non-renewable). Types of Crude Oils, Composition and Properties. Crude oil assay.		
Credit: 1+0+2	**Paper: Elective (Major)**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

++Unit	**Topics**	**No. of Lecture**
Unit I	**Review of energy sources (renewable and non-renewable):** Classification of fuels and their calorific value.Determination of calorific value by Bomb calorimeter and Junker's calorimeter.	3
Unit II	**Coal:** Analysis of coal, Proximate and ultimate Analysis, Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas composition and uses. Fractionation of coal tar, uses of coal tar based chemicals, requisites of a good metallurgical coke, Coal gasification (Hydrogasification and Catalytic gasification), Coal liquefaction and Solvent Refining.	3

Unit III	**Petroleum and Petrochemical Industry:** Composition of crude petroleum, Refining and different types of petroleum products and their applications.	3
Unit IV	Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.	3
Unit V	Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene. Lubricants: Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants. Properties of lubricants (viscosity index, cloud point, pore point and aniline Point) and their determination.	3

Suggested Readings:

1.Stocchi, E.(1990),Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VIII**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23114A	**Course Title: Lab work based on theory**

Course Objective: Hands on experience to determine pore point, cloud point, viscosity etc of fuel.

Course Outcome: After completing this course, the students will be able to -

CO1. Explain test methods for petroleum products
CO2. Prepare biodiesel from vegetable oil .
CO3. Calculate calorific value of a fuel .
CO4: Determine pore point and cloud point of fuel .

Credit: 0+0+2	**Paper: Elective (Major)**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

List of Practicals	No. of Practical (Hrs)
1.Test Methods for Petroleum products 2. To prepare biodiesel from vegetable oil 3. Calorific value of a fuel 4. Characterization of different petroleum products using UV and IR 5. To determine pore point and cloud point of fuel 6. To determine the viscosity of biodiesel ay various temperature using biodiesel. 7. To determine free fatty acid content in given sample. 8. To determine the density of the given fuel sample.	**60**

Suggested Readings:
1. Stocchi, E.(1990),Industrial Chemistry, Vol -I, Ellis Horwood Ltd. UK. 2.Lab Manual
Course. prerequisite: To study this course, the students must have had science stream in class 12th
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks

Or

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VIII**
Pedagogy: Lectures in class rooms, videos, presentations, Transaction through an intelligent mix of conventional and modern methods, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23114B	**Course Title:** Food Additives, Contamination & Safety	
Course Objectives: To understand the chemistry of food additives and their applications This has been designed to impart theoretical and practical knowledge on common food additives, contaminants and adulterants. The analytical approach of this course is to enhance the understanding of safety measures of food and evaluation techniques to determine toxicity of additives. This course also enhances knowledge about regulations and monitoring agencies of food		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Understand and describe applications of various food additives in food processing and preservation. **CO.2** Know the merits and demerits of synthetic and natural colouring, flavouring and sweetening agents as food additives. **CO.3** Identify and prevent potential sources of food contamination. **CO.4** Know different types food contaminants. **CO.5** Know Safety measures of food additives, regulations and monitoring agencies and toxicological evaluation of additives.		
Credit: 1+0+2	**Paper: Elective (Major)**	
Max. Marks: 40+60 (30T+30P)	**Min Passing Marks: 35**	
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		

Unit	**Topics**	**No. of Lecture**
Unit I	**Food Additives:** Introduction, need of food additives in food processing and preservation. Characteristics and classification of food additives. Sweeteners- Introduction, importance, classification- natural and artificial, chemistry, technology and toxicology,	3
Unit II	Antimicrobial agents. -Nitrites, sulphides, sulphur dioxide, sodium chloride, hydrogen peroxide. Antioxidants - Introduction, mechanism of action, natural and synthetic antioxidants, technological aspect of antioxidants. consideration for choosing sweetening agents. Colors- Introduction, importance, classification- natural, artificial, and natural identical, FD&C Dyes and Lakes. polymeric colors.	3
Unit III	Food Contamination & adulterants Lectures: 12 Contamination in Food: Physical, chemical contaminants- heavy metals, pesticide residues, agrochemicals, Antibiotics and Veterinary Drug residues, environmental pollutants, radionuclides, solvent residues, NOTS (Naturally Occurring Toxic Substances).	3

Unit IV	Contaminants formed during processing & packaging – nitrosamines, acrylamide, alloys, benzene, dioxins, furans, persistent organic pollutants, polymers, PAH (Polycyclic Aromatic Hydrocarbons) in smoked foods, food. fumigants, autoxidation products. Food adulteration - Common adulterants in foods and tests to detect common adulterants.	3
Unit V	Food Safety, Risks and hazards, Food related hazards, regulations and monitoring agencies, interaction of additives with food ingredients and their toxicological aspects, quality evaluation of additives and contaminants, Acute and chronic studies, NOEL, ADI, LD50.	3

Suggested Readings:

1.DeMan. (2007). Principles of Food Chemistry. Springer, 3rdedition

2. Emerton, V, (2008). Food Colours. Blackwell Publishing.

3. Wilson, R. (2007).Sweeteners. Blackwell Publishing.

4. Fennema OR.(1996). Food Chemistry. Marcel Dekker.

5. Pieternel A, Luning. & Willem, J. Marcelis. (2009). Food Quality Management Technological and Managerial principles and practices. Wageningen.

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

[Lab Work/Practicals]

Programme: B.Sc. /B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth year**	**Semester: VIII**

Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.

Course Code: CHE-23114B	**Course Title: Lab work based on theory**

Course Objective: Hands on experience to determine moisture content, total sugar content etc.

Course Outcome: After completing this course, the students will be able to -

CO1. Determine of moisture content of foods by oven drying.
CO2. Determine reducing and total sugar content in foods.
CO3. Separate and identify sugars and amino acids.
CO4: Determine quality standards and inspection of spices and condiments.

Credit: 1+0+2	**Paper: Elective (Major)**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**

Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60

List of Practicals	**No. of Practical (Hrs)**

1. Determination of moisture content of foods by oven drying. 2. Determination of reducing and total sugar content in foods. 3. Chromatographic Separation and identification of sugars and amino acids. 4. Testing of turmeric powder, milk and mustard oil for adulterants. 5. Extraction of natural coloring and flavoring agent from flowers and fruits 6. Inspection of various food grains- cereals and coarse cereals 7. Determination of quality standards and inspection of spices and condiments. 8. Qualitative tests for hydrogenated fats, butter, and ghee. 9. Estimation of sulphur dioxide in beverages. 10. Qualitative estimation of benzoic acid in ketchup and sauces. 11. Chromatographic estimation of colour. 12. Study the effect of aerial oxidation of food.	**60**

Suggested Readings:

1.Ranganna, S., & Ranganna, S. (2003). Handbook of analysis and quality control for fruit and vegetable products. New Delhi: Tata McGraw-Hil.

2.Nielsen, S. S. (2017). Food analysis.

3. Vogel, Arthur I. (Arthur Israel). (1989). Vogel's textbook of quantitative chemical analysis. Harlow, Essex, England : New York :Longman Scientific & Technical ; Wiley,

4.Lab Manual

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;

Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

Or

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: Third Year**	**Semester: VIII**
Pedagogy: Lectures in class rooms, videos, presentations, Engaging students in cooperative learning, Learning through quiz design, Problem solving to enhance comprehension.		
Subject: Chemistry		
Course Code: CHE-23114C	**Course Title:** Business Skills for Chemists	
Course Objectives: The objective of this course is to enhance the business and entrepreneurial skills of undergraduate chemistry students and improve their employment prospects. The course will orient the students to understand the Industry linkage with chemistry, challenges and business opportunities. It will expose the students to the concepts of intellectual property rights, patents and commercialisation of innovations.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Learn basics skills of of business and project management. **CO.2** Understand the process of product development and business planning that includes environmental compliancy. **CO.3** Learn the process by which technical innovations are conceived and converted into successful business ventures. **CO.4** Understand the intellectual property rights and patents which drive business viability and commercialization of innovation. **CO.5** Relate to the importance of chemistry in daily life, along with the employment and business opportunities. They will effectively use the skills to contribute towards the well-being of the society and derive commercial value.		

Credit: 1+0+2		Paper: Elective (Major)
Max. Marks: 40+60 (30T+30P)		Min Passing Marks: 35
Total Number of Lectures (Lecture +Tutorials + Practical): 15+0+60		
Unit	**Topics**	**No. of Lecture**
Unit I	**Chemistry in industry**: Current challenges and opportunities for the chemistry based industries. Role of chemistry in India and global economies. Chemistry based products in the market.	3
Unit II	**Business Basic:** Key business concepts, Business plans, Market need, Project management, Routes to market, Concept of entrepreneurship	3
Unit III	**Project Management Different stages of a project:** • Ideation • Bench work • Pilot trial • Production • Promotion/ Marketing	3
Unit IV	**Commercial Realisation and Case Studies:** • Commercialisation • Case study of Successful business ideas in chemistry • Case study of Innovations in chemistry • Financial aspects of business with case studies	3
Unit V	**Intellectual Property Rights**: Introduction to IPR & Patents **Environmental Hazards**: Industries involving hazardous chemicals. Importance of development of cost-effective alternative technology. Environmental ethics. Students may be asked to prepare business plan based on some innovative ideas and submit as a project / presentation discussing its complete execution.	9
Suggested Readings: 1. www.rsc.org 2. Nwaeke, L.I.(2002),Business Concepts and Perspectives, Springfield Publishers. 3. Silva, T. D. (2013),Essential Management Skills for Pharmacy and Business Managers, CRC Press.		
Course prerequisite: To study this course, the students must have had science stream in class 12th.		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

[Lab Work/Practicals]

Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	Year: B.Sc. Fourth year	Semester: VIII
Pedagogy: Videos, Teaching Learning Process for the course is visualized as largely student-focused, Engaging students in cooperative learning, Learning through practical experience to enhance comprehension.		
Course Code: CHE-23114C	**Course Title: Lab work based on theory**	
Course Objective: Gain knowledge on case study, report writing.		
Course Outcome: After completing this course, the students will be able to -		
CO.1 Learn basics skills of of business and project management. **CO.2** Understand the process of product development and business planning that includes environmental compliancy.		

CO.3 Learn the process by which technical innovations are conceived and converted into successful business ventures.
CO.4 Understand the intellectual property rights and patents which drive business viability and commercialization of innovation.
CO.5 Relate to the importance of chemistry in daily life, along with the employment and business opportunities. They will effectively use the skills to contribute towards the well-being of the society and derive commercial value.

Credit: 1+0+2	**Paper: Elective (Major)**
Max. Marks: 40+60 (30T+30P)	**Min. Passing Marks: 35**
Total Number of Lectures (Lecture + Tutorial + Practical): 0 + 0 + 60	
List of Practicals	**No. of Practical (Hrs)**
Experiment/case study would be decided by instructor.	**60**

Course. prerequisite: To study this course, the students must have had science stream in class 12th

Suggested Continuous Evaluation Methods:
Continuous Internal Evaluation shall be of 40% in two Steps in a Semester , C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under ;
Assignment/Practical/Projects – 05 Marks
Internal Class Test – 10 Marks
Attendance/Behavior – 05 Marks

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Programme: B.Sc.(Honours)/B.Sc.(Honours with Research) in Chemistry	**Year: B.Sc. Fourth Year**	**Semester: VIII**

Pedagogy: The assessment will be through evaluation of the dissertation, presentation, report writing and viva voce involving external and internal examiners.

Course Code: CHE-23115A/CHE-23115B	**Course Title: Dissertation/Research Project & Viva-voce (Honours with research)** **or** **Field Visit/Tour Based Viva-voce (Honours)**

Course Objectives: The Objective is to enable student to identify a problem in the field of chemistry and to carry out literature survey, design an experiment, perform experiment, analyse data and write a report.

Course Outcome: After completing this course, the students will be able to -

CO.1 Do survey, study and cite published literature on a particular area of interest.
CO.2 Correlate the experimental observations with theoretical understanding.
CO.3 Interpret results, write a report and submit to the supervisor.
CO.4. Use laboratory resources judiciously.
CO.5 Work in a team under the supervision of a teacher.

Credits: 0+0+12	**Paper: Core Compulsory**
Max. Marks: 100(40+60)	**Min. Passing Marks: 35**
Total Number of Lectures (Lecture + Tutorial +Practical): 0 + 0 +360	

Unit	Topics	No. of Lectures
Unit I	Develop scientific writing : Identification of research problem	360
Unit II	Survey of literature	
Unit III	Formulation of hypothesis, experimental design and methodology	
Unit IV	Analysis of data and interpretation of results uses.	
Unit V	• Discussion and conclusion • Writing a project report skill.	
Course prerequisite: To study this course, the students must have had science stream in class 12^{th}.		
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be of 40% in two Steps in a Semester, C1 (After 45 Days) & C2 (After 90 Days) respectively. Marks of Each Internal assessment will be distributed as under; Assignment/Practical/Projects – 05 Marks Internal Class Test – 10 Marks Attendance/Behavior – 05 Marks		

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