Manonmaniam
Sundaranar University

B.Sc CHEMISTRY SYLLABUS

(for affiliated colleges)

ACADEMIC YEAR 2026-2027

MANONMANIAM SUNDARANAR UNIVERSITY

TIRUNELVELI

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MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

OUTCOME BASED EDUCATION - CHOICE BASED CREDIT SYSTEM

OPERATIONAL GUIDELINES FOR FRAMING CURRICULUM

1. VISION OF THE UNIVERSITY

"To provide quality education to reach the un-reached".

2. MISSION OF THE UNIVERSITY

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled**.**

3. PREAMBLE

Outcome Based Education (OBE) has emerged as an effective approach in higher education to ensure quality, skill oriented and learner centered education. The Choice Based Credit System (CBCS) provides flexibility in curriculum design enables students to acquire knowledge, skills and competencies according to their interests and career aspirations. The curriculum is designed to promote flexibility, critical thinking, problem solving ability and lifelong learning through effective teaching, learning, and assessment practices. The revised curriculum framework integrates Programme Educational Outcomes (PEOs), Programme Outcomes (POs), Programme Specific Outcomes (PSOs), and Course Outcomes (COs) in alignment with the Vision and Mission of the University. The adoption of Revised Bloom's Taxonomy (RBT) ensures effective attainment of knowledge, skills, ethical values, and employability among learners. The courses are systematically designed

and mapped to ensure that the outcomes of all courses collectively contribute to the achievement of the programme outcomes and the holistic development of students. It enables the students to excel in the fields of education, fundamental and advanced research in Chemistry by providing quality education so that they can compete and contribute to the varying technology.

4. PROGRAMME EDUCATIONAL OUTCOMES (PEO)

In alignment with the Vision and Mission of the University, the following have been defined as the PEO for the graduates.

PEO1: Developing strong positive attitude to learn independently the concepts in the field of study

PEO2: Ensuring confidence among the learners to apply the knowledge and skills gained to solve real life issues

PEO3: Habituating ethical values among the learners to succeed in personal and professional life

5. PROGRAMME OUTCOMES (PO)

Programme Outcomes for the Under Graduate Degree Programmes of the University are articulated as under.

After the successful completion of Undergraduate Programme from the University, the learner should be able to

PO1: Comprehend the knowledge acquired and communicate the same to others.

PO2: Analyse and compare the factual data / situation to comprehend and to critically evaluate to find solution to the problem ahead.

PO3: Apply theories and philosophies learned in solving the problem in scientific manner.

PO4: Think reflectively on the earlier activities and attempt for self-directed lifelong learning process.

PO5: Understand multicultural existence and identify the means to prolong moral/ethical values in personal and professional life.

PO6: Explore through multiple sources and get exposed to the digital technology.

PO7: Act as a responsible member in teams and practice leadership qualities.

6. PROGRAM SPECIFIC OUTCOMES (PSOs)

On successful completion of Bachelor of Chemistry programme, the student should be able to:

PSO1: Disciplinary Knowledge:

Understand the fundamental principles, concepts, and theories related to chemistry. Also, exhibit proficiency in performing experiments in the laboratory.

PSO2: Critical Thinking:

Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively.

PSO3: Problem Solving:

Employ theoretical concepts and critical reasoning ability with chemistry and practical skills to solve problems, acquire data, analyze their physical significance and explore new scientific findings.

PSO4: Analytical & Scientific Reasoning:

Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.

PSO5: Research related skills:

Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.

PSO6: Self-directed & Lifelong Learning:

Continuously update the knowledge by lifelong learning and contribute to the growth and development of science and technology.

PSO7: Employability and Entrepreneurship

Develop skills for employability, entrepreneurship, and career readiness in industry, education, and technology-driven sectors.

Each Course has to address a minimum of 4 PSOs

- **COURSE OUTCOMES (CO)**

Four Course Outcomes (COs) for each course that can be achieved by the learners on completion of that particular course are as follows:

Considering outcomes related to

i. K1 and K2 level of evaluation in all the Units as CO1

ii. K3 level of evaluation in all the Units as CO2

iii. K4 level of evaluation in all the Units as CO3

iv. K5 and K6 level of evaluation in all the Units as CO4.

All the COs proposed in each of the courses should be mapped with Pos and PSOs based on the relevance.

Level of Correlation between COs with Pos and PSOs.

0 – No Correlation 1 – Low 2 – Medium 3 – High

7. PROGRAMME DETAILS

i. Eligibility for the B. Sc Chemistry Programme

The candidate seeking admission to the B. Sc Chemistry programme must have passed the Higher Secondary Examination, conducted by Government of Tamil Nadu or an equivalent examination in the science stream, with Physics, Chemistry, Mathematics, Biology or Computer science as subjects.

ii. Medium of Instruction: The medium of instruction is English.

iii. Duration of the Programme: B. Sc Chemistry programme is a three year under graduate course comprising six semesters. Each semester consists of 90 working days.

8. Examination Scheme

The Course Outcomes (COs) are measured through the performance of learners by direct and indirect assessment methods for that particular course.

- B.Sc Chemistry curriculum is divided and studied in six semesters.
- The internal assessments and external examination are the two parts of evaluation scheme.

- The external theory and practical examinations will be conducted by the university at the end of each semester.
- There is a separate passing minimum of 40% for the external and overall components.
- Theory Marks 25: 75
- Practical Marks 50: 50

Note: In both Internal and Semester End Examinations

Lower Order Thinking (K1, K2, & K3) – 60 % in each part

Higher Order Thinking (K4, K5, & K6) – 40 % in each part

Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the undergraduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.

i. Internal assessment (25 marks)

- **Internal Marks for Theory shall be allotted in the following manner**

The average of the best two tests from three compulsory tests. Each test is of one hour duration.	20 marks
Assignment / Seminars	05 marks
Total	25 Marks

- **Internal Marks for Practical shall be allotted in the following manner**

Experiments (a minimum of six experiments) done in the class alone should be recorded. Students having a bonafide record only should be permitted to appear for the practical examination.

Experimental work	25 marks
Regularity	25 marks
Total	50 marks

- **Internal marks for major Project and viva-voce shall be allotted in the following manner**

Internal Marks: 50; External Marks: 50

Internal Marks for Project:

Experimental work	25 marks
Project report	25 marks
Total	50 marks

ii. External assessment

Theory: 75 marks

Practical/ Project: 50 marks

iii. Project Evaluation

Project report evaluation and Viva-Voce will be conducted by both the External examiner and the Guide at the end of the semester.

iv. Practical Evaluation

Practical evaluation will be conducted by both the External examiner /Internal examiner at the end of the semester.

- **Internship**

Report for Internship / Industrial Visit / Field Visit / Research Institute Visit.

Should be evaluated along with the project at the end of V^{th} semester.

Students should submit a report for internship / industrial visit / field visit / Research institute visit/ knowledge up dation activity at the end of the fifth semester with attendance certificate from the concern organisation.

The duration of internship should be 30 hours.

Internal: 50 marks; External: 50 marks

- **Extension Activity:**

The student should participate in any one of the programmes like NSS, NCC, YRC, RRC, games and sports/ youth welfare activity, outreach programmes etc. the examination / report / evaluation will be conducted at the end of sixth semester.

- **Naan mudhalvan programme** is compulsory for all the students. Those who failed in naan mudhalvan can write exam for the substitute subject.

9. Question Paper Pattern

The question pattern for all theory courses shall be as follows.

Duration of Exam: 3 Hours

Section	**Type of questions**	**Mark Distribution**
Part A	Ten Multiple choice question (Two question from each unit compulsory)	10 x1=10 Marks
Part B	Five Internal Choice questions (One question from each unit: either or choice)	5x5=25 marks
Part C	Five Internal Choice questions (One question from each unit: either or choice)	5x8=40 marks
	Total	**75 Marks**

10. Model Question Paper

MODEL QUESTION PAPER

GENERAL CHEMISTRY-I **(For those who joined in July 2026 onwards)** **Time: Three hours** **Maximum:75 marks**		
	Part-A (10×1=10 marks) **Answer All questions**	
1	Which of the following elements has the highest first ionization energy? a) Sodium, b) Chlorine, c) Argon, d) Potassium	K1
2	According to Pauli's exclusion principle, the maximum number of electrons in an atomic orbital is ---. a) 1 electron, b) 2 electrons, c) 4 electrons, d) 8 electrons	K2
3	In quantum mechanics, the quantity Ψ^2 represents----. a) Energy, b) Momentum, c) Probability density, d) Atomic radius	K2

4	The tendency of an atom to attract electrons is called----. a) Ionization energy, b) Atomic radius, c) Electronegativity d) Electron affinity	K1
5	Which bond is formed by complete transfer of electrons? a) Covalent bond, b) Hydrogen bond, c) Ionic bond d) Metallic bond	K1
6	The shape of a molecule with AB_2 type and no lone pairs is-----. a) bent, b) linear, c) trigonal planar, d) tetrahedral	K2
7	In MO theory, a bond formed by constructive overlap of orbitals is called---. a) antibonding orbital, b) non-bonding orbital c) bonding orbital, d) hybrid orbital	K1
8	Which type of intermolecular force is responsible for hydrogen bonding? a) Weak metallic attraction, b) Attraction of electronegative atoms c) Electron sharing in covalent bond, d) Nuclear attraction	K3
9	Which intermediate has a positive charge on carbon? a) Carbanion, b) Carbocation, c) Free radical, d) Carbene	K2
10	The nucleophilic species in organic reactions are said to ------. a) accept electron pairs, b) donate electron pairs c) carry positive charge, d) break sigma bonds.	K3
	PART- B (5 x 5 = 25 Marks)	
11	(a). Explain the Franck–Hertz experiment and its importance in supporting Bohr's atomic theory. OR (b). Describe the Pauli exclusion principle, Hund's rule, and Aufbau principle used in electronic configuration of atoms.	K2
12	(a). Write the differences between a Bohr orbit and an orbital in the wave mechanical model of the atom. OR (b). Analyse the periodic trends of atomic radius, ionization energy, and electronegativity across a period and down a group in the modern	K4

	periodic table.	
13	(a). According to Fajans' rules, predict the nature of compounds such as NaCl, $AlCl_3$, and MgO with suitable justification. OR (b). Explain the shapes of AB_2, AB_3, AB_4, AB_5, and AB_6 type molecules with examples using VSEPR theory.	K3
14	(a). Describe the bonding and magnetic nature of molecules such as O_2, N_2, and CO in accordance with the Valence Bond Theory and Molecular Orbital Theory. OR (b) Discuss the effect of intermolecular forces on the physical properties like boiling point, melting point, and stability of substances such as water and DNA.	K6
15	(a). Explain the difference between homolytic and heterolytic bond cleavage with suitable examples. OR (b) Describe the inductive effect and explain its influence on the acidity of halo acids and basicity of amines.	K2
	PART- C (5 X 8 = 40 Marks)	
16	(a). Analyse the experimental evidence provided by Rutherford's scattering experiment and explain how it led to the nuclear model of the atom. OR (b). the dual nature of matter and radiation by explaining de Broglie hypothesis and its confirmation through the Davisson–Germer experiment.	K4
17	(a). Evaluate the importance of Schrödinger wave equation and the significance of Ψ and Ψ^2 in explaining the probability and electron density of orbitals. OR (b). Discuss the role of electronegativity and ionization energy in determining the chemical behaviour and bonding nature of elements in the modern periodic table.	K5
18]	(a). Describe how Born–Haber cycle is used to determine lattice energy and assess its importance in explaining the stability of ionic	K5

	compounds. OR (b). Discuss the effect of polarization in explaining the transition from ionic to covalent character in compounds and its effect on physical properties.	
19	(a). Explain with neat diagram of Molecular Orbital Theory of O_2, O_2^+, O_2^-, and N_2 and determine the bond order and magnetic nature. OR (b) Explain the shapes and geometries of CO_2, NO_3^-, CO_3^{2-}, and NH_4^+ molecules/ions with suitable explanation.	K3
20	(a). Apply inductive effect and resonance concepts to compare the acidity of haloacids and phenols with suitable examples and explanation. OR (b). Illustrate the concepts of hyperconjugation and resonance with suitable example to explain the stability of alkenes and carbocations.	K3

11. Entire Programme Structure for UG Chemistry with Credit Distribution.

B.Sc Chemistry - First Year

Semester-I

Part	List of Courses	Credit	Hours per week (L/T/P)
Part-I	Language	3	6
Part-II	English	3	6
Part-III	Core Courses 2 (CC1, CC2)	8	8
	Elective Course1(Generic / Discipline Specific) EC1	5	6
Part-IV	Skill Enhancement Course SEC-1 (Non Major Elective)	2	2
	Foundation Course FC	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	Hours per week (L/T/P)
Part-I	Language	3	6
Part-II	English	3	4
Part-III	Core Courses 2 (CC3, CC4)	8	8
	Elective Course1(Generic/ Discipline Specific) EC2	5	6
Part-IV	Skill Enhancement Course-SEC-2	1	2
	Skill Enhancement Course-SEC-3 (Discipline Specific/Generic)	1	2
	Ability Enhancement Compulsory Course (AECC2) SoftSkill-2- Naan mudhalvan	2	2
		23	**30**

Second Year

Semester-III

Part	List of Courses	Credit	Hours per week (L/T/P)
Part-I	Language	3	6
Part-II	English	3	6
Part-III	Core Courses 2(CC5, CC6)	6	6
	Elective Course1(Generic / Discipline Specific) EC3	6	6
Part-IV	Skill Enhancement Course-SEC-4 (Entrepreneurial Based)	2	2
	Environmental Studies (EVS)	2	2
	Naan mudhalvan	2	2
		24	**30**

Semester-IV

Part	List of Courses	Credit	Hours Per week (L/T/P)
Part-I	Language	3	6
Part-II	English	3	6
Part-III	Core Courses 2 (CC7, CC8)	8	6

	CC7: Core Industry Module-1		
	CC8: Any Core paper		
	Elective Course 1(Generic / Discipline Specific) EC4	5	6
Part-IV	Skill Enhancement Course-SEC-6	1	2
	Skill Enhancement Course- Naan mudhalvan	2	2
	Value based education	2	2
		24	**30**

Third Year
Semester-V

Part	**List of Courses**	**Credit**	**Hours per week (L/T/P)**
Part-III	Core Courses 3 (CC9, CC10, CC11)	12	15
	Core / Project with viva-voce (CC12)	4	5
	Elective Courses 2 (Generic / Discipline Specific) EC5, EC6	6	8
Part-IV	Ability enhancement compulsory course soft skill -5 Naan Mudhalvan	2	2
	Internship / Industrial Training / Field Visit / Knowledge Updating (Carried out in II year summer vacation -30 hours)	1	-
		25	**30**

Semester-VI

Part	List of Courses	**Credit**	**Hours per week (L/T/P)**
Part-III	Core Courses 3 (CC13, CC14, CC15)	12	15
	Elective Courses 2 (Generic/ Discipline Specific) EC7, EC8	6	11
Part-IV	Professional Competency Skill Enhancement Course -SE8 Naan mudhalvan	2	4
Part-V	Extension Activity (Outside college hours)	1	-
		21	**30**

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i. Credit Distribution for UG Programme in Chemistry

Sem I	Credit	Sem II	Credit	Sem III	Credit	Sem IV	Credit	Sem V	Credit	Sem VI	Credit
1.1. Language	3	2.1. Language	3	3.1. Language	3	4.1. Language	3	5.1. Core Course CC9	4	6.1. Core Course CC13	4
1.2. English	3	2.2. English	3	3.2. English	3	4.2. English	3	5.2. Core Course CC10	4	6.2. Core Course CC14	4
1.3. Core Course CC1	4	2.3. Core Course CC3	4	3.3. Core Course CC5	4	4.3. Core Course CC7	4	5.3. Core Course CC11	4	6.3. Core Course CC15	4
1.4. Core Course CC2	4	2.4. Core Course CC4	4	3.4. Core Course CC6	4	4.4. Core Course CC8	4	5.4. Core / Project CC12	4	6.4. Elective EC7	3
1.5. Elective EC1	5	2.5. Elective EC2	5	3.5. Elective EC3	4	4.5. Elective EC4	4	5.5. Elective EC5	3	6.5. Elective EC8	3
1.6. Skill Enhancement Course SEC1	2	2.6. Skill Enhancement Course SEC2	1	3.6. Skill Enhancement Course SEC4	2	4.6. Skill Enhancement Course SEC5	2	5.6. Elective EC6	3	6.6. Naan Mudhalvan	2
1.7. Skill Enhancement (Foundation Course)	2	2.7. Skill Enhancement Course SEC3	1	3.7. EVS	2	4.7. Value Education	2	5.7. Naan Mudhalvan	2	6.7. Extension Activity	1
-	-	2.8. Naan Mudhalvan 1	2	3.8. Naan Mudhalvan 2	2	4.8. Naan Mudhalvan 3	2	5.8. Internship	1		
-	-	-	-								
	23		**23**		**24**		**24**		**25**		**21**

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ii. Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	12	12	22	18	90
Part IV	4	4	6	6	3	2	25
Part V	-	-	-	-	-	1	1
Total	23	23	24	24	25	21	140

iii. B.Sc CHEMISTRY CURRICULUM DESIGN - 2026-2027 and onwards)

PART	Subject Code	List of courses	Credit	Hours Per Week L/T/P
		SEMESTER –I		
Part –I		Tamil/ Malayalam	3	6
Part-II		English	3	6
Part-III	CC1	General chemistry-1	5	5
	CC2	Quantitative inorganic estimation	3	3P
	EC1	Mathematics / Zoology	5	6
Part- IV	SEC-1	Food chemistry	2	2L
	FC	Foundation course in Chemistry	2	2
		Total	**23**	**30**
		SEMESTER –II		
Part –I		Tamil/ Malayalam	3	6
Part-II		English	3	4
Part-III	CC3	General chemistry-II	5	5
	CC4	Qualitative organic analysis	3	3P
	EC2	Mathematics / Zoology	5	6
Part- IV	SEC-2	Dairy chemistry	1	2
	SEC-3	Role of Chemistry in daily life	1	2

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		Naan Mudhalvan-Cambridge course - English / *Cosmetics and personal grooming	2	2
		Total	**23**	**30**

The *Naan Mudhalvan substitute course for semesters II is available to individuals who is absent or fail, and they have to appear external exams for 100 marks.

iv. ALLIED CHEMISTRY (GENERIC ELECTIVE)

CHEMISTRY FOR PHYSICAL SCIENCES I For Mathematics and Physics students Year –I/II				
	Subject code	List of courses	Credit	Hours Per Week L/T/P
		Semester – I/III		
1	GE I or III	Chemistry for Physical sciences- I	3	4L
2	GE IP or III P	Inorganic Volumetric analysis – practical	2	2P
		Semester – II/IV		
3	GE II or IV	Chemistry for Physical sciences – II	3	4L
4	GE IIP or IVP	Systematic analysis of Inorganic salts	2	2P
CHEMISTRY FOR BIOLOGIAL SCIENCES For Botany and Zoology students Year –I/ II Semester –I/ III				
1	GE I or III	Chemistry for Biological sciences- I	3	4L
2	GE IPor IIIP	Inorganic Volumetric analysis – practical	2	2P
		Semester –II / IV		
3	GE II or IV	Chemistry for Biological sciences- II	3	4L
4	GE II or IVP	Systematic analysis of Inorganic salts	2	2P

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	Category	Course type	Course code	Course title	Contact Hours/ Week	Exam hours	Marks			Credit
							CIA	External	Total	
SEM -I	Part –I	Language		Tamil/ Malayalam	6	3	25	75	100	3
	Part -II	Language		English	6	3	25	75	100	3
	Part -III	Core	CC1	General chemistry-1	5	3	25	75	100	5
		Core practical	CC2	Quantitative inorganic estimation	3P	3	50	50	100	3
		Elective	EC1	Mathematics -/Zoology/ Botany	6-4	3	25	75	100	5
				Zoology/Botany practical	2P	3	50	50	100	
	Part - IV	Skill enhancement course	SEC-1	Food chemistry	2	3	25	75	100	2
		Foundation course	FC	Foundation course in Chemistry	2	3	25	75	100	2
				Total	**30**					**23**
SEM - II	Part –I	Language		Tamil/ Malayalam	6	3	25	75	100	3
	Part -II	Language		English	4	3	25	75	100	3
	Part -III	Core	CC3	General chemistry-II	5	3	25	75	100	5
		Core practical	CC4	Qualitative organic analysis	3P	3	50	50	100	3
		Elective course	EC2	Mathematics - Zoology/ Botany	6 4	3	25	75	100	6
				Zoology/Botany practical	2P	3	50	50	100	
	Part - IV	Skill enhancement course	SEC-2	Dairy chemistry	2	3	25	75	100	1
			SEC-3	Role of chemistry in daily life	2	3	25	75	100	1
				Naan Mudhalvan- Cambridge course - English / * Cosmetics and personal grooming	2	-	-	100	100	2
				Total	**30**					**23**

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v. B.Sc CHEMISTRY PROGRAMME - MARK DISTRIBUTION (2026-2027 and onwards)

ALLIED CHEMISTRY -GENERIC ELECTIVE										
CHEMISTRY FOR PHYSICAL SCIENCES I For Mathematics and Physics students Year –I/II										
	Category	Course type	Course code	Course title	Contact Hours/ week	Exam hours	Marks			Credit
							CIA	External	total	
SEM 1 /III	Part III	Generic elective	GE I	Chemistry for physical sciences- I	4	3	25	75	100	3
		Generic Elective practical	GE IP	Inorganic volumetric analysis -	2P	3	50	50	100	2
SEM II/IV	Part -III	Generic elective	GE II	Chemistry for physical sciences – II	4	3	25	75	100	3
			GE IIP	Analysis of inorganic salts	2P	3	50	50	100	2
	CHEMISTRY FOR BIOLOGIAL SCIENCES For Botany and Zoology students Year –I/ II									
SEM I/III	Part III	Generic elective	GE I	Chemistry for biological sciences- I	4	3	25	75	100	3
		Generic Elective practical	GE IP	Inorganic volumetric analysis -	2P	3	50	50	100	2
SEM II/IV	Part -III	Generic Elective	GE II	Chemistry for biological sciences- II	4	3	25	75	100	3
		Generic Elective practical	GE IIP	Analysis of Inorganic salts	2P	3	50	50	100	2

12. Course -PSO mapping

Mapping of Course Outcomes (COs) with Programme Specific Outcomes (PSOs)

Course	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
General Chemistry -1	3	3	2	3	3	2	3
Quantitative Inorganic estimation	3	3	3	3	3	2	3
Food chemistry	3	3	3	3	3	2	3
Foundation course in chemistry	3	3	2	3	2	2	3

13. Detailed Syllabus with L-P-T Distribution of hours

SEMESTER I

Title of the Course	**GENERALCHEMISTRY-I**						
Paper No.	**Core- I**						
Category	**Core**	**Year**	I	**Credits**	5	**Course Code**	
		Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	4	1	-			5	
Pre requisites	Higher secondary chemistry						

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Recall and explain the atomic structure, wave particle duality of matter, periodic properties bonding, and properties of compounds.	K1,K2
CO2	Apply the theories of atomic structure, bonding, to calculate energy of a spectral transition, Δx,Δp electronegativity, percentage ionic character and bond order.	K3
CO3	Analyze the trends in periodic properties, assess the properties of elements, and explain hybridization in molecules, nature of H – bonding and organic reaction	K4,

	mechanisms.	
CO4	Evaluate the relationship existing between electronic configuration, bonding, geometry of molecules and reactions; structure reactivity, electronic effects and construct MO diagrams.	K5,K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT- I** **Atomic structure and Periodic trends** History of atom (J. J. Thomson, Rutherford); Moseley's Experiment and Atomic number, Atomic Spectra; Black-Body Radiation and Planck's quantum theory-Bohr's model of atom; The Franck-Hertz Experiment; Interpretation of H- spectrum; Photoelectric effect, Compton effect; Dual nature of Matter-De-Broglie wavelength- Davisson and Germer experiment Heisenberg's Uncertainty Principle; Electronic Configuration of Atoms and ions-Hund's rule, Pauli' exclusion principle and Aufbau principle; Numerical problems involving the core concepts.	
	Unit-II **Introduction to Quantum mechanics** Classical mechanics, Wave mechanical model of atom, distinction between a Bohr orbit and orbital; Postulates of quantum mechanics; probability interpretation of wavefunctions, Formulation of Schrodinger wave equation – Probability and electron density-visualizing the orbitals -Probability density and significance of Ψ and Ψ^2. **Modern Periodic Table** **Cause of periodicity**; Features of the periodic table; classification of elements - Periodic trends for atomic size- atomic radii, Ionic, crystal and Covalent radii; ionization energy, electron affinity, electronegativity-electronegativity scales, applications of electronegativity. Problems involving the core concepts	
	UNIT-III **Structure and bonding–I** **Ionic bond** Lewis dot structure of ionic compounds; properties of ionic compounds; Energy involved in ionic compounds; Born Haber cycle–lattice energies, Madelung constant; relative effect of lattice energy and solvation energy; Ion polarization – polarising power and polarizability; Fajans' rules - effects of polarisation on properties of compounds; problems involving the core concepts. **Covalent bond** Shapes of orbitals, overlap of orbitals – σ and Π bonds; directed valency -	

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	hybridization; VSEPR theory-shapes of molecules of the typeAB_2, AB_3, AB_4, AB_5, AB_6 and AB_7 Partial ionic character of covalent bond-dipole moment, application to molecules of the type A_2, AB, AB_2, AB_3, AB_4; percentage ionic character- numerical problems based on calculation of percentage ionic character.
	UNIT-IV **Structure and bonding–II** VB theory–application to hydrogen molecule; concept of resonance- resonance, Structures of some inorganic species–CO_2, NO_2, CO_3^{2-}, NO_3^- limitations of VBT;MO theory - bonding, antibonding and nonbonding H_2, C_2, O_2, O_2^+, O^{2-}, O^{2-},N_2, NO, HF, CO; CO_2.Magnetic characteristics, comparison of VB and MO theories. Coordinate bond: Definition, Formation of BF_3, NH_3, NH_4^+, H_3O^+properties, Metallic bond-electron sea model, VB model; Band theory-mechanism of conduction in solids; conductors, insulator, semiconductor – types, applications of semiconductors,. Weak Chemical Forces - Vander Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces; Hydrogen bonding–Types, special properties of water, ice, stability of DNA; Effects of chemical force, melting and boiling points.
	UNIT-V **Basic concepts in Organic Chemistry and Electronic effects** Types of bond cleavage – heterolytic and homolytic; arrow pushing in organic reactions; reagents and substrates; types of reagents -electrophiles, nucleophiles, free radicals; reaction intermediates – carbanions, carbocations, carbenes, arynes and nitrynes. Inductive effect –reactivity of alkyl halides, acidity of halo acids, basicity of amines; inductomeric and electromeric effects. Resonance – resonance energy, conditions for resonance - acidity of phenols, basicity of aromatic amines, of carbonium ions, carbanions and free
	radicals, reactivity of vinyl chloride, dipole moment of vinyl chloride and nitrobenzene, bond lengths; steric inhibition to resonance. Hyperconjugation-stability of alkenes, bond length, orienting effect of methyl group, dipole moment of aldehydes and nitromethane Types of organic reactions-addition, substitution, elimination and rearrangements

Extended Professional component, not to be included in the external examination question paper.	Questions related to the above topics, from various competitive examinations UPSC/JAM /TNPSC and others to be solved (To be discussed during the Tutorial hours)
Skills acquired From this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. Madan. R.D, and SathyaPrakash, Modern Inorganic Chemistry,2nd ed.; S. Chand and Company: New Delhi, 2003. 2. Rao, C.N.R. University General Chemistry, Macmillan Publication: New Delhi, 2000. 3. Puri, B.R. and Sharma, L.R. Principles of Physical Chemistry, 38th ed.; Vishal Publishing Company: Jalandhar,2002. 4. Bruce, P. Y .and Prasad K.J.R. Essential Organic Chemistry, Pearson Education: New Delhi, 2008. 5. Dash U.N, Dharmarha O.P, Soni. P.L. Textbook of Physical Chemistry, Sultan Chand & Sons: New Delhi,2016
Reference Books	1. Maron, S.H, and Prutton C.P. Principles of Physical Chemistry, 4 thed.; The Macmillan Company: Newyork,1972. 2. Lee, J.D. Concise Inorganic Chemistry,4 th ed.; ELBS William Heinemann: London,1991. 3. Gurudeep Raj, Advanced Inorganic Chemistry,26th ed.; Goel Publishing House: Meerut, 2001. 4. Atkins, P.W.& Paula, J. Physical Chemistry,10thed.; Oxford University Press: New York, 2014. 5. Huheey. J. E, Inorganic Chemistry: Principles of Structure and Reactivity, 4th ed.; Addison, Wesley Publishing Company: India,1993.
Web site and e-learning source	1) https://onlinecourses.nptel.ac.in 2) http://www.mikeblaber.org/oldwine/chm1045/notes_m.htm 3) http://www.ias.ac.in/initiat/sci_ed/resources/chemistry/Inorganic.html 4) https://swayam.gov.in/course/64-atomic-structure-and-chemical-bonding https://www.chemtube3d.com/

Level of correlation between COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	0	2	0	0
CO2	2	3	2	2	1	1	3
CO3	3	2	3	3	3	2	0
CO4	1	2	3	2	2	2	3

Level of correlation between COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	2	1	3
CO2	3	3	2	3	3	2	3
CO3	3	3	3	3	2	2	3
CO4	3	2	1	2	3	3	2
TOTAL	12	10	8	11	10	8	11
AVERAGE	3	3	2	3	3	2	3

Title of the Course	**Quantitative Inorganic Estimation (Titrimetry)**						
Paper No.	**Core- II**						
Category	**Core**	**Year**	I	**Credits**	2	**Course Code**	
		Semester	I				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	-	-	3			3	
Pre requisites	Higher secondary chemistry						
COURSE OUTCOMES							COGNITIVE LEVELS
CO1	Explain the principles, and Perform redox, dichrometry, argentimetry and complexometry titrations for quantitative estimation of analytes.						K1,K2
CO2	Apply the various volumetric methods for the						

	estimation of reducing and oxidizing agents and determination of ions and compounds.	K3
CO3	Analyse the presence of reducing and oxidizing agents, metal ions and compounds.	K4,
CO4	Evaluate the suitability of different volumetric techniques and design experimental procedures for quantitative chemical analysis with accuracy and safety.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**Unit- I Chemical Laboratory Safety in Academic Institutions** Introduction - importance of safety education for students, common laboratory hazards, assessment and minimization of the risk of the hazards, prepare for emergencies from uncontrolled hazards; concept of MSDS; importance and care of PPE; proper use and operation of chemical hoods and ventilation system; fire extinguishers-types and uses of fire extinguishers, demonstration of operation; chemical waste and safe disposal. **Common Apparatus Used in Quantitative Estimation (Volumetric)** Description and use of burette, pipette, standard flask, measuring cylinder, conical flask, beaker, funnel, dropper, clamp, stand, wash bottle, watch glass, wire gauge and tripod stand. **Principle of Quantitative Estimation (Volumetric)** Equivalent weight of an acid, base, salt, reducing agent, oxidizing agent; concept of mole, molality, molarity, normality; primary and secondary standards, preparation of standard solutions; theories of acid-base, redox, complex metric, iodimetric and iodometric titrations**;** indicators – types, theory Of acid–base, redox, meta ion and adsorption indicators, choice of indicators.	
	Unit - II Quantitative Estimation (Volumetric) Preparation of standard solution, dilution from stock solution	
	Permanganometry 1. Estimation of sodium oxalate using standard ferrous ammonium sulphate. **2.** Estimation of ferrous sulphate using standard oxalic acid.	
	Dichrometry 3. Estimation of ferric alum using standard dichromate (external indicator) 4.Estimation of ferric alum using standard dichromate (internal	

	indicator)
	Iodometry 5.Estimation of copper in copper sulphate using standard dichromate.
	Argentimetry 6.Estimation of chloride in barium chloride using standard sodium chloride/Estimation of chloride in sodium chloride (Volhard's method)
	Unit III Complexometry 7. Estimation of hardness of water using EDTA. 8. Estimation of nickel in steel using standard calcium chloride solution. **ESTIMATIONS** 9. Estimation of iron in iron tablets. 10. Estimation of ascorbic acid.
Skills acquired From this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	**Reference Books:** 1. Venkateswaran. V., Veeraswamy. R., Kulandivelu. A.R, Basic Principles of Practical Chemistry,2nded.; Sultan Chand &Sons: New Delhi, 1997. 2. Nad. A. K., Mahapatra. B, Ghoshal. A., An advanced course in Practical Chemistry, 3rd ed., New Central Book Agency: Kolkata,2007.
Website and e-learning source	**Web References:** 1) http://www.federica.unina.it/agraria/analytical-chemistry/volumetric-analysis https://chemdictionary.org/titration-indicator/

Level of correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	1	1
CO2	3	3	3	2	1	2	1
CO3	3	3	2	3	2	1	1

CO4	3	3	3	3	2	3	2

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Level of correlation of COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	2	2	2
CO2	3	3	3	2	2	2	3
CO3	3	3	2	3	2	3	3
CO4	3	3	3	3	3	2	2
Total	12	11	10	10	10	9	10
Average	3	3	3	3	3	2	3

Title of the Course	**FOOD CHEMISTRY**						
Paper No	**SEC- I**						
Category	**SEC**	**Year**	I	**Credits**	2	**Course Code**	
		Semester	I				
Instructional hours per Week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	2	-	-			2	
Pre-requisites	Higher secondary Chemistry						

COURSE OUTCOMES		**COGNITIVE LEVEL**
CO1	Recall and explain the concepts of food adulteration, food poisoning, food additives, beverages, and edible oils.	K1, K2
CO2	Apply the principles of food chemistry to identify adulterants, preservatives, additives, and quality parameters of food products and beverages.	K3
CO3	Analyze the causes, effects, safety aspects, and chemical composition of food materials, edible oils, additives, and food contaminants.	K4,
CO4	Evaluate food quality and safety standards and design suitable methods for detection, preservation, and quality control of food products.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT- I Food Adulteration** Sources of food, types, advantages and disadvantages. Food adulteration - contamination of wheat, rice, milk, butter etc. with clay stones, water and toxic chemicals -Common adulterants, Ghee adulterants and their detection. Detection of adulterated foods by simple analytical techniques.	

	Unit- II Food Poison Food poisons - natural poisons (alkaloids –nephron toxin) - pesticides, (DDT, BHC, Malathion) -Chemical poisons - First aid for poison consumed victims.
	Unit- III Food Additives Food additives-artificial sweeteners–Saccharin- Cyclomate and Aspartate Food flavours-esters, aldehydes and heterocyclic compounds – Food colours –Emulsifying agents–preservatives-leavening agents. Baking powder–yeast–taste makers–MSG-vinegar.
	UNIT-IV Beverages Beverages-soft drinks-soda-fruit juices-alcoholic beverages-examples. Carbonation-addiction to alcohol– diseases of liver and social problems
	UNIT-V Edible Oils Fats and oils - Sources of oils - production of refined vegetable oils - preservation. Saturated and unsaturated fats-iodine value-role of MUFA and PUFA in preventing heart diseases-determination of iodine value, RM value, saponification values and their significance.
Recommend ed Text	1.Food chemistry, H.K. Chopra, P.S. Panesar, Narosa publishing house,2010. 2.Jayashree Ghosh, Fundamental Concepts of Applied Chemistry, S. Chand & Co. Publishers, second edition, 2006. 3.Food Chemistry, Dr. L. Rakesh Sharma, Evince pub publishing,2022. 4.Food processing and preservation, G. Subbulakshmi, Shobha. A Udipi, Padmini S. Ghugre, New age international publishers, 2nd edition, 2021.
Reference Books	1. H.D. Belitz, Werner Grosch, Food Chemistry Springer Science &Business Media,4th Edition, 2009. 2. M. Swaminathan, Food Science and Experimental Foods, Ganesh and Company,1979. 3. Hasen huettl Gerard. L, Hartel Richard. W. Food Emulsifiers and their applications Springer New York 2nd ed. 2008. 4. H.D. Belitz, W. Grosch, P. Schieberle, Food Chemistry, Springer, fourth revised and extended edition, 2009. Principles of food chemistry, John M. de Man, John W. Finley, W. Jefferey Hurst, Chang Yong Lee, Springer, Fourth edition, 2018.
Website and e-learning Source	https://onlinecourses.nptel.ac.inhttp://cactus.dixie.edu/smblack/chem1010/lec

Level of correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	1
CO2	3	3	2	2	1	3	1
CO3	3	3	2	3	2	3	1
CO4	3	3	3	3	2	3	2

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	1	1	3
CO2	3	3	2	2	3	2	3
CO3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	2	2
Total	12	11	10	10	10	8	10
Average	3	3	3	3	3	2	3

Title of the Course	**FOUNDATION COURSE**							
Paper No.	**SEC**							
Category	**SEC**	**Year**	I	**Credits**	2	**Course Code**		
		Semester	I					
Instructional hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**		
	2	-	-			2		
Prerequisites	Higher secondary chemistry							

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Recall and explain the basic concepts of atomic structure, periodic classification of elements, chemical bonding, states of matter, organic nomenclature, isomerism, and spectroscopy.	K1,K2
CO2	Apply the fundamental principles of chemical bonding, periodic properties, nomenclature, and states of matter to solve simple chemical problems.	K3
CO3	Analyze the relationship between atomic structure, bonding, molecular properties, physical states, and spectral behavior of chemical substances.	K4,

CO4	Evaluate and design simple approaches for classification, identification, and interpretation of chemical compounds and their properties based on fundamental chemical principles.	K5, K6
K 1 –Remember K 2 – Understand K 3 – Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT-I** **Structure of atom and periodic classification of Elements and properties.** Atom structure-Fundamental particles- atomic mass - atomic number– Isotopes–Isobars– Isotones – Orbitals-Quantum number and their significance. Shapes of s, p and d orbitals- Rules governing electronic configuration in various its atomic orbitals. Periodic table-periodic laws (Mendeleev and Mosley)-Classification of elements into s, p, d and f-blocks. Metals - Non-metals -Periodic Properties-Concept, Variation and factors affecting various periodic properties-Inert pair effect.	
	Unit-II **Chemical Bonding** Definition-Types of chemical bond-Ionic bond-Ion polarization-Dipole moment and Percentage of ionic character-Covalent bond - Definition–Postulates of Valence bond theory and Concept of hybridization (sp, sp^2, sp^3, sp^3d, sp^3d^2, dsp^2, d^2sp^3) –Magnetic properties – Paramagnetic–Diamagnetic-Ferromagnetic Co-ordinate covalent bond-Definition– Examples-Co-ordination compounds (basic concepts only).	
	UNIT- III Nomenclature and Isomerism in Organic compounds Carbon compounds-Uniqueness of carbons-Classification of hydrocarbons-IUPAC Nomenclature of Organic compounds Isomerism: Structural and Stereoisomerism Structural Isomerism: Chain isomerism, Functional isomerism, Positional isomerism and Meta isomerism. Stereo isomerism: Geometrical and Optical Isomerism-Chiral Molecule-Enantiomers- Diastereomers- Meso Compounds-Racemic mixture.	
	UNIT- IV States of Matter **Gaseous state**: Kinetic theory of gases- Ideal and Non-ideal gases- Ideal gas equation- Deviation of ideal gas from ideal behaviour - Vander Waal's equation and Liquification of gases. **Liquids:** Intermolecular forces, Vapour pressure and Boiling point of liquid- Surface tension –Viscosity- Factors affecting surface tension and viscosity. **Solids:** Definition-Characteristics of solids-Amorphous and Crystalline Solids – Space Lattice and unit cells-Close packed structure of solids-	

	Radius ratio rule.
	UNIT -V Introduction to Spectroscopy Electromagnetic radiation-General characteristics of Wave–Wave length – Frequency– Amplitude – Wave number - Electromagnetic spectrum- Absorption and Emission spectrum - Quantization of Energy level - Selection rule - Intensity of the Spectral lines– Width of Spectral lines. Types of Spectroscopy: Microwave spectroscopy, Infrared spectroscopy, UV-Visible spectroscopy, Nuclear Magnetic Resonance spectroscopy, Electron spin resonance spectroscopy.
Text Books	1.B.R. Puri, L.R. Sharma, K.C. Kalia, Principles of Inorganic Chemistry Milestone Publishers and Distributors, New Delhi,2012. 2. B.R. Puri and L.R. Sharma, 38th edition, Vishal Publishing company Jalendar2002. 3. K.S. Tewari, S.N. Mehrothra and N. K. Vishnoi, Textbook of Organic Chemistry, 2nd edition Vikas publishing House, New Delhi, 1998.
Reference books	1. R.D. Madan, Sathya Prakash, Mordern Inorganic chemistry 2nd edition S. Chand and company, New Delhi, 2003. 2. B.S. Bhal, Arun Bhal, Advanced Organic chemistry, 3rd edition, S Chand and company, New Delhi, 2003. 3. U.N. Dash, O. P. Dharmarha, P.L. Soni, Textbook of Physica Chemistry, Sultan Chand & sons, New Delhi, 2016. 4. Y.R. Sharma Organic spectroscopy Principles and Chemica applications, S. Chand &Company PVT Ltd, 2002. C.N. Banwell, Fundamentals of spectroscopy Tata Mc Graw Hill, 1983.
Website and e-learning Source	https://onlinecourses.nptel.ac.inhttp://cactus.dixie.edu/smblack/chem1010/lec

Level of correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	1	1
CO2	3	3	2	2	1	1	1
CO3	3	3	2	3	2	1	1
CO4	3	3	2	3	2	2	2

Level of correlation of COs with PSOs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	3	3	3
CO2	3	3	2	2	2	1	2
CO3	3	3	2	3	2	3	3
CO4	3	3	2	3	2	2	2
Total	12	11	9	10	9	9	10
Average	3	3	2	3	2	2	3

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SEMESTER II

Title of the Course	**GENERAL CHEMISTRY-II**						
Paper No.	**Core- III**						
Category	**Core**	**Year**	I	**Credits**	5	**Course Code**	
		Semester	II				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	4	1	-			5	
Pre requisites	General Chemistry I						

COURSE OUTCOMES		COGITIVE LEVELS
CO1	Recall and explain the fundamental concepts of acids, bases, ionic equilibria, chemistry of s- and p-block elements, and hydrocarbon chemistry including aliphatic and aromatic hydrocarbons.	K1,K2
CO2	Apply the principles of ionic equilibria, periodic properties, and hydrocarbon reactions to solve basic chemical problems and reaction mechanisms.	K3
CO3	Analyze the properties, reactivity, stability, and mechanisms of inorganic compounds and hydrocarbons including aromatic systems.	K4,
CO4	Evaluate chemical behaviour and suitable approaches for predicting reactions, structures, and applications of inorganic and organic compounds.	K5, K6

K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create

Course Outline	**UNIT-I Acids, bases and Ionic equilibria** Concepts of Acids and Bases - Arrhenius concept, Bronsted-Lowry concept, Lewis concept; Relative strengths of acids, bases and dissociation constant; dissociation of poly basic acids, ionic product of water, pH scale, pH of solutions; Degree of dissociation, common ion effect, factors affecting degree of dissociation; acid base indicators, theory of acid base indicators – action of phenolphthalein and methyl orange, titration curves - use of acid base indicators; Buffer solutions – types, mechanism of buffer action in acid and basic buffer, Henderson-Hasselbalch equation; Salt hydrolysis - salts of weak acids and strong bases, weak bases and strong acids, weak acids and weak bases - hydrolysis constant, degree of hydrolysis and relation between hydrolysis constant and degree of hydrolysis; Solubility product-determination and applications; numerical problems Involving the core concepts**.**

	Unit-II Chemistry of s-Block Elements Hydrogen: Position of hydrogen in the periodic table. Alkali metals: Comparative study of the elements with respect to oxides, hydroxides, halides, carbonates and bicarbonates. Diagonal relationship of Li with Mg. Preparation, properties and uses of NaOH, Na_2CO_3, KBr, $KClO_3$ alkaline earth metals. Anomalous behaviour of Be. **Chemistry of p-Block Elements (Group 13 &14)** Preparation and structure of diborane and borazine. Chemistry of borax. Extraction of Al and its uses. Alloys of Al. Comparison of carbon with silicon. Carbon-di-sulphide–Preparation, properties, structure and uses. Percarbonates, per mono carbonates and per dicarbonates.
	UNIT-III Chemistry of p-Block Elements (Group15-18) General characteristics of elements of Group 15; chemistry of H_2N-NH_2, NH_2OH, NH_3 and HNO_3. Chemistry of PH_3, PCl_3, PCl_5, $POCl_3$, P_2O_5 and oxy acids of phosphorous ($H_3PO_3$and H_3PO_4). General properties of elements of group16 - Structure and allotropy of elements - chemistry of ozone - Classification and properties of oxides - oxides of sulphur and selenium – Oxy acids of sulphur (Caro's and Marshall's acids). Chemistry of Halogens: General characteristics of halogen with reference to electro- negativity, electron affinity, oxidation states and oxidizing power. Peculiarities of fluorine. Halogen acids (HF, HCl, HBr and HI), oxides and oxy acids ($HClO_4$). Inter-halogen compounds (ICl, ClF_3, BrF_5 an dIF_7), pseudo halogens [$(CN)_2$ and $(SCN)_2$]and basic nature of Iodine. Noble gases: Position in the periodic table. Preparation, properties and structure of XeF_2, XeF_4, XeF_6 and $XeOF_4$; uses of noble gases – clathrate compounds.
	UNIT-IV **Hydrocarbon Chemistry-I** **Petroproducts:** Fractional distillation of petroleum; cracking, isomerisation, alkylation, reforming and uses. **Alkenes**-Nomenclature, general methods of preparation – Mechanism of elimination reactions–E_1 and E_2 mechanism-factors influencing–stereochemistry–orientation – Hofmann and Saytzeff rules. Reactions of alkenes–addition reactions–mechanisms - Markownikoff's rule, Kharasch effect, oxidation reactions–hydroxylation, oxidative degradation, epoxidation, ozonolysis; polymerization. **Alkadienes** Nomenclature - classification – isolated, conjugated and cumulated dienes; stability of conjugated dienes; mechanism of electrophilic addition to conjugated dienes - 1, 2 and 1, 4 additions; free radical addition to conjugated dienes– Diels–Alder reactions – polymerisation – polybutadiene, polyisoprene (natural rubber), vulcanisation, polychloroprene.

	Alkynes Nomenclature; general methods of preparation, properties and reactions; acidic nature of terminal alkynes and acetylene, polymerisation and isomerisation. **Cycloalkanes:** Nomenclature, Relative stability of cycloalkanes, Bayer's strain theory and its limitations. Conformational analysis of cyclohexane, mono and di substituted cyclohexanes, Geometrical isomerism in cyclohexanes.
	UNIT-V **Hydrocarbon Chemistry-II** **Benzene:** Source, structure of benzene, stability of benzene ring, molecular orbital picture of benzene, aromaticity, Huckel's $(4n+2)\pi e^-$ rule and its applications. Electrophilic substitution reactions - General mechanism of aromatic electrophilic substitution - nitration, sulphonation, halogenations. Friedel-Craft's alkylation and acylation. and disubstituted benzene -Effect of substituent–orientation and reactivity. **Polynuclear Aromatic hydrocarbons**: Naphthalene – nomenclature, Haworth synthesis; physical properties, reactions – electrophilic substitution reaction, nitration, sulphonation, halogenation, Friedel – Crafts acylation & alkylation, preferential substitution at o-,p- or m- position – reduction, oxidation – uses. Anthracene – synthesis by Elbs reaction, Diels – Alder reaction and Haworth synthesis; physical properties; reactions - Diels-Alder reaction, preferential substitution at C-9 and C-10; uses.
Extended Professional component, not to be included in the external examination question paper.	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.

Recommended Text	1. Madan R. D, Sathya Prakash, (2003), Modern Inorganic Chemistry, 2nd ed, S. Chand and Company, New Delhi. 2. Sathya Prakash, Tuli G. D, Basu S. K and Madan R. D, (2003), Advanced Inorganic Chemistry, 17th ed., S. Chand and Company, New Delhi. 3. Bahl B S, Arul Bhal, (2003), Advanced Organic Chemistry, 3rd ed., S. Chand and Company, New Delhi. 4. Tewari K. S, Melhothra S. N and Vishnoi N. K, (1998), Text book of Organic Chemistry, 2nd ed., Vikas Publishing House, New Delhi. 5. Puri B R, Sharma L R, (2002), Principles of Physical Chemistry, 38th ed., Vishal Publishing Company, Jalandhar.
Reference Books	1. Maron. S, Hand Prutton. C.P, (1972), Principles of PhysicalChemistry,4th ed., The Macmillan Company, New York. 2. Barrow G. M, (1992), PhysicalChemistry,5th ed., Tata Mc Graw Hill, New Delhi. 3. Lee. J. D, (1991), Concise Inorganic Chemistry, 4th ed., ELBS William Heinemann, London. 4. Huheey. J. E, (1993), Inorganic Chemistry: Principles of Structure and Reactivity, 4thed., Addison Wesley Publishing Company, India. 5. Gurudeep Raj, (2001), Advanced Inorganic Chemistry Vol – I, 26thed., Goel Publishing House, Meerut. 6. Agarwal. O. P, (1995), Reactions and Reagents in Organic Chemistry, 8th ed., Goel Publishing House, Meerut.
Website and e-learning source	https://onlinecourses.nptel.ac.inhttp://cactus.dixie.edu/smblack/chem1010/lecture_notes/4B.html http://www.auburn.edu/~deruija/pdareson.pdfhttps://swayam.gov.in/course/64-atomic-structure-and-chemical-bonding **MOOC components** http://nptel.ac.in/courses/104101090/ Lecture 1: Classification of elements and periodic

Level of correlation of COs with Pos.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	2	3	2
CO2	3	3	2	2	1	1	3
CO3	3	3	1	3	2	1	1
CO4	3	3	2	3	2	2	2

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	3	2	3
CO2	3	3	2	2	3	3	3
CO3	3	3	3	3	2	2	2
CO4	3	3	2	3	2	2	2
Total	12	11	10	10	10	9	10
Average	3	3	3	3	3	2	3

Title of the Course	**QUALITATIVE ORGANIC ANALYSIS**						
Paper No.	**Core – IV**						
Category	**Core**	**Year**	I	**Credits**	3	**Course Code**	
Instructional hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	-	-	3			3	
Pre requisites	General Chemistry-II						

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Explain the principles, reactions, reagents, and systematic procedures involved in the qualitative organic analysis of different functional groups.	K1, K2
CO2	Apply suitable laboratory techniques and chemical tests to identify functional groups present in unknown	K3

	organic compounds.	
CO3	Analyse experimental observations, reaction behaviour, and confirmatory test results to differentiate and identify organic functional groups systematically.	K4
CO4	Evaluate analytical results critically and design systematic schemes for the qualitative identification of organic compounds containing various functional groups.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT-I** Safety rules, symbols and first-aid in chemistry laboratory Basic ideas about Bunsen burner, its operation and parts of the flame. Chemistry laboratory glassware –basis information and uses.	
	Unit- II **Qualitative Organic Analysis** Preliminary examination, detection of special elements -nitrogen, sulphur and halogens Aromatic and aliphatic nature, Test for saturation and unsaturation, identification of functional groups using solubility tests	
	Confirmation of functional groups • Monocarboxylic acid, dicarboxylic acid • Monohydric phenol, polyhydric phenol • aldehyde, ketone, ester • carbohydrate (reducing and non-reducing sugars) • primary, secondary, tertiary amine • monoamide, diamide, thioamide • anilide, nitro compound Preparation of derivatives for functional groups.	
Reference Books	1. Venkateswaran, V.; Veeraswamy, R.; Kulandai Velu, A.R. Basic Principles of Practical Chemistry, 2nd ed.; Sultan Chand: New Delhi, 2012. 2. Manna, A.K. Practical Organic Chemistry, Books and Allied: India, 2018. 3. Gurtu, J. N; Kapoor, R. Advanced Experimental Chemistry (Organic), Sultan Chand: New Delhi, 1987. 4. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R.	

	Vogel's Textbook of Practical organic Chemistry, 5thed.; Pearson: India,1989.
Website and e- learning Source	https://www.vlab.co.in/broad-area-chemical-sciences

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	1	2	1
CO2	3	2	2	3	2	3	2
CO3	2	1	3	3	3	3	1
CO4	2	2	3	3	3	2	2

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	3	3	2	3
CO2	3	3	2	3	2	1	3
CO3	3	3	3	2	2	2	2
CO4	2	2	3	2	3	3	2
Total	11	10	10	10	10	8	10
Average	3	3	3	3	3	2	3

MSU

<table>
<tr><td>Title of the Course</td><td colspan="7">DAIRY CHEMISTRY</td></tr>
<tr><td>Paper No</td><td colspan="7">SEC –II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">1</td><td rowspan="2">Course Code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Pre requisites</td><td colspan="7">Higher secondary chemistry</td></tr>
<tr><td colspan="6">COURSE OUTCOMES</td><td colspan="2">COGNITIVE LEVELS</td></tr>
<tr><td>CO1</td><td colspan="5">Describe the composition, properties, processing methods, and classification of milk and milk products.</td><td colspan="2">K1, K2</td></tr>
<tr><td>CO2</td><td colspan="5">Apply the principles of dairy chemistry in the processing, preservation, and quality assessment of milk and dairy products.</td><td colspan="2">K3</td></tr>
<tr><td>CO3</td><td colspan="5">Analyse the chemical composition, processing techniques, and quality parameters of various dairy and fermented milk products.</td><td colspan="2">K4,</td></tr>
<tr><td>CO4</td><td colspan="5">Evaluate the nutritional and industrial significance of dairy products and develop systematic approaches for the preparation and quality improvement of milk products.</td><td colspan="2">K5, K6</td></tr>
<tr><td colspan="8">K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT- I
Composition of Milk
Milk-definition-general composition of milk- constituents of milk - lipids, proteins, carbohydrates, vitamins and minerals –physical properties of milk - colour, odour, acidity, specific gravity, viscosity and conductivity - Factors affecting the composition of milk - adulterants, preservatives with neutralizer- examples and their detection- estimation of fat, acidity and total solids in milk.</td></tr>
<tr><td colspan="7">UNIT- II
Processing of Milk
Microbiology of milk- destruction of micro-organisms in milk, Physico–chemical changes taking place in milk due to processing - boiling, pasteurization – types of pasteurization - Bottle, Batch and HTST (High Temperature Short Time) – Vacuum pasteurization – Ultra High Temperature Pasteurization.</td></tr>
</table>

	UNIT -III **Major Milk Products** Cream - definition - composition - chemistry of creaming process - gravitational and centrifugal methods of separation of cream-estimation of fat in cream. Butter-definition -composition - theory of churning – desi butter - salted butter, estimation of acidity and moisture content in butter. Ghee –major constituents –common adulterants added to ghee and their detection–rancidity-definition-prevention-antioxidants and synergists-Natural and synthetic.
	UNIT- IV **Special Milk** Standardised milk - definition - merits - reconstituted milk - definition – flow diagram of manufacture - Homogenised milk - flavoured milk – vitaminised milk - toned milk – Incitation milk-Vegetable toned milk-humanized milk-condensed milk-definition, Composition and nutritive value.
	UNIT- V **Fermented and other Milk Products** Fermented milk products–fermentation of milk-definition, conditions, cultured milk -definition of culture-example, conditions-cultured cream, butter milk-Bulgarious milk-acidophilous milk–Yoheer Indigeneous products-khoa and chhena definition- Ice cream -definition-percentage composition-types-ingredients-manufacture of ice– cream, stabilizers - emulsifiers and their role-milk powder-definition- Need for making milk powder-drying process-types of drying.

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Recommended Text	1. K. Bagavathi Sundari, Applied Chemistry, MJP Publishers, first edition, 2006. 2. K.S. Rangappa and K.T. Acharya, Indian Dairy Products, Asia Publishing House New Delhi, 1974. 3. Text book of dairy chemistry, M.P. Mathur, D. Datta Roy, P. Dinakar, Indian Council of Agricultural Research, 1 st edition, 2008. 4. A Text book of dairy chemistry, Saurav Singh, Daya Publishing house, 1 st edition, 2013. 5. Text book of dairy chemistry, P.L. Choudhary, Bio-Greenbookpublishers,2021.
Reference Books	1. Robert Jenness and S. Patom, Principles of Dairy Chemistry, S. Wiley, New York, 2005. 2. F.P. Wond, Fundamentals of Dairy Chemistry, Springer, Singapore,2006. 3. Sukumar De, Outlines of Dairy Technology, Oxford University Press, New Delhi, 1980. 4. P.F. Fox and P.L.H. Mc sweeney, Dairy Chemistry and Biochemistry, Springer, Second edition, 2016. 5. Dairy chemistry and bio chemistry, P.F. Fox, T. Uniacke - Lowe, P.L.H. McSweeney, J.A.O Mahony, Springer, Second edition,2015.
Website and e-learning source	e-pathshala https://www.agrilcareer.com-pdf

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	2	3	2
CO2	3	1	2	2	2	2	3
CO3	2	3	3	3	3	2	2
CO4	2	2	3	3	3	2	3

Level of correlation of COs with POs and PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	3	2	3
CO2	3	3	2	3	2	1	3
CO3	3	3	3	2	2	2	2
CO4	2	2	3	3	3	3	2
Total	11	10	10	10	10	8	10
Average	3	3	3	3	3	2	3

<table>
<tr><td>Title of the Course</td><td colspan="7">ROLE OF CHEMISTRY IN DAILY LIFE</td></tr>
<tr><td>Paper No.</td><td colspan="7">SEC-III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">1</td><td>Course</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I</td><td>Code</td></tr>
<tr><td>Instructional</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>Hours per week</td><td>2</td><td>-</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Pre requisites</td><td colspan="7">Higher secondary chemistry</td></tr>
<tr><td colspan="2">COURSE OUTCOMES</td><td colspan="5"></td><td>COGNITIVE LEVELS</td></tr>
<tr><td>CO1</td><td colspan="5">Explain the role of chemistry in daily life, including air, water, building materials, food, fuels, drugs and dyes.</td><td>K1, K2</td></tr>
<tr><td>CO2</td><td colspan="5">Apply the knowledge of chemicals, food components, fuels, plastics and drugs in solving day-to-day problems.</td><td>K3</td></tr>
<tr><td>CO3</td><td colspan="5">Analyse the impact of chemicals, cosmetics, food additives, fuels and industrial materials on health and environment.</td><td>K4,</td></tr>
<tr><td>CO4</td><td colspan="5">Evaluate the uses and hazards of chemicals in daily life and create awareness for safe and sustainable utilization of chemical products.</td><td>K5, K6</td></tr>
<tr><td colspan="7">K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate
K 6 – Create</td></tr>
<tr><td rowspan="2">Course Outline</td><td colspan="7">UNIT-I
General survey of chemicals used in everyday life. Air - components and their importance; photosynthetic reaction, air pollution, green - house effect and the impact on our life style. Water - Sources of water, qualities of potable water, soft and hard water, methods of removal of hardness-water pollution</td></tr>
<tr><td colspan="7">Unit-II
Building materials - cement, ceramics, glass and refractories - definition, composition and application only. Plastics - polythene, PVC, bakelite, polyesters, melamine-formaldehyde resins-preparation and uses only.</td></tr>
</table>

	UNIT-III **Food and Nutrition** - Carbohydrates, Proteins, Fats - definition and their importance as food constituents – balanced diet – Calories minerals and vitamins (sources and their physiological importance). Cosmetics – tooth paste, face powder, soaps and detergents, shampoos, nail polish, perfumes-general formulation and preparations – possible hazards of cosmetic use.
	UNIT-IV **Chemicals in food production** – fertilizers - need, natural sources; urea, NPK fertilizers and super phosphate. Fuel–classification-solid, liquid and gaseous; nuclear fuel examples and uses.
	UNIT-V **Pharmaceutical drugs** - analgesics and antipyretics - paracetamol and aspirin. Colour chemicals-pigments and dyes-examples and applications. Explosives - classification and examples.
Recommended Text	1. Food chemistry, H.K. Chopra, P.S. Panesar, Narosa publishing house, 2010. 2. A text book of pharmaceutical chemistry by Jaya shree Ghosh, S Chand publishing, 2012. 3. S. Vaithyanathan, Textbook of Ancillary Chemistry; Priya Publications, Karur, 2006. 4. B. K, Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.Introduction to forensic chemistry, Kelly M. Elkins, CRC Press Taylor & Francis Group, 2019. 5. Jayashree Ghosh, Fundamental Concepts of Applied Chemistry, S. Chand & Co. Publishers, second edition, 2006.
Reference Books	1. Randolph. Norris Shreve, Chemical Process Industries, McGraw-Hill, Texas, fourth edition, 1977. 2. W.A. Poucher, Joseph. A. Brink, Jr. Perfumes, Cosmetics and Soaps, Springer, 2000. 3. A. K. De, Environmental Chemistry, New Age International Public Co.,1990.
Website and e-learning source	

MSU

Level of correlation of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	2	1	2	1
CO2	3	3	2	1	2	2	3
CO3	2	3	3	2	3	3	2
CO4	2	2	3	3	2	3	3

Level of correlation of COs with POs and PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	2	2	3
CO2	3	3	2	2	2	2	2
CO3	3	3	3	2	3	2	2
CO4	3	2	3	3	3	3	2
Total	12	10	10	9	10	9	10
Average	3	3	3	2	3	2	3

Title of the Course	***COSMETICS AND PERSONAL GROOMING**						
Paper No	**Naan Mudhalvan (**substitute)						
Category	**SEC**	**Year**	I	**Credits**	2	**Course Code**	
		Semester	II				
Instructional hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
		-	-			2	
Pre requisites	Higher secondary chemistry						
COURSE OUTCOMES						COGNITIVE LEVELS	
CO1	Explain the composition, functions, and applications of cosmetic products used for skin care, hair care, dental care, makeup, perfumes, and beauty treatments.					K1,K2	

CO2	Apply the principles of cosmetic chemistry in the selection, preparation, and safe usage of personal grooming and beauty care products.	K3
CO3	Analyse the chemical ingredients, formulations, quality parameters, and effects of various cosmetic and personal care products.	K4,
CO4	Evaluate the effectiveness and safety of cosmetic products and develop suitable formulations or innovative approaches for personal grooming and beauty treatments.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT- I Skin care** Nutrition of the skin, skincare and cleansing of the skin; face powder–ingredients; creams and lotions – cleansing, moisturizing all purpose, shaving and sunscreen (formulation only); Gels – formulation and advantages; astringent and skin tonics – key ingredients, skin lightness, depilatories.	
	UNIT- II Hair care Shampoos–types–powder, cream, liquid, gel –ingredients; conditioner –types– ingredients **Dental care** Toothpastes–ingredients–mouthwash	
	UNIT- III Makeup Base–foundation–types–ingredients; lipstick, eyeliner, mascara, eyeshadow, concealers, rouge	
	UNIT- IV Perfumes Classification-Natural–plant origin–parts of the plant used, chief constituents; animal origin–ambergris from whale, civetone from civet cat, musk from musk deer; synthetic –classification emphasizing- characteristics– esters – alcohols – aldehydes – ketones	
	UNIT- V Beauty treatments Facials - types – advantages – disadvantages; face masks – types; bleach -types– advantages– disadvantages; shaping the brows; eyelash tinting; perming – types; hair colouring and dyeing; permanent waving – hair straightening; wax types – waxing; pedicure, manicure - advantages – disadvantages	
Recommended Text	1. Thankamma Jacob, (1997) Foods, drugs and cosmetics –A consumer guide, Macmillan publication, London.	

Reference Books	2. Wilkinson. J. B. E. and Moore. R. J, (1997) Harry's cosmeticology,7th ed., Chemical Publishers, London. 3. George Howard, (1987) Principles and practice of perfumes and cosmetics, Stanley Therones, Chettenham.
Website and e-learning source	http://www.khake.com/page75.html Net.foxsm/list/284

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	0	1	1	2
CO2	3	2	2	2	2	2	3
CO3	2	2	3	3	3	2	2
CO4	2	3	3	3	3	2	3

MSU

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	2	2	3
CO2	3	2	2	3	2	2	3
CO3	3	3	2	3	2	3	2
CO4	3	3	3	3	3	3	2
Total	12	11	10	12	9	10	10
Average	3	3	3	3	2	3	3

ALLIED CHEMISTRY (GENERIC ELECTIVE)

Title of the course	**CHEMISTRY FOR PHYSICAL SCIENCES - I (FOR MATHEMATICS AND PHYSICS STUDENTS)**						
Paper No.	Generic Elective – 1						
Category	Generic Elective	Year	I/II	Credits	3	Course code	
		Semester	I/III				
Instructional hours per week	Lecture	Tutorial	Lab Practice	Total			
	4	-	-	4			
Pre-requisites	Higher secondary chemistry						

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Explain the fundamental principles of chemical bonding, nuclear chemistry, industrial chemistry, organic chemistry, thermodynamics, phase equilibria, and analytical chemistry.	K1, K2
CO2	Apply chemical concepts, theories, equations, and analytical techniques to solve problems related to bonding, industrial processes, organic reactions, thermodynamics, and chemical analysis.	K3
CO3	Analyse chemical behaviour, reaction mechanisms, thermodynamic systems, phase equilibria, industrial	K4,

	processes, and analytical data using scientific reasoning.	
CO4	Evaluate chemical processes and analytical methods critically and develop systematic approaches or solutions for chemical and industrial applications.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		

Course Outline	**UNIT- I** **Chemical Bonding and Nuclear Chemistry**: Molecular Orbital Theory-bonding, antibonding and non-bonding orbitals. Molecular orbital diagrams for Hydrogen, Helium, Nitrogen; discussion of bond order and magnetic properties. Nuclear Chemistry: Fundamental particles Isotopes, Isobars, Isotones and Isomers-Differences between chemical reactions and nuclear reactions - group displacement law. Nuclear binding energy - mass defect calculations. Nuclear fission and nuclear fusion differences - Stellar energy. Applications of radioisotopes - carbon dating, rock dating and applications.
	Unit –II **Industrial Chemistry** Fuels: Fuel gases: Natural gas, water gas, semi water gas, carbureted water gas, producer gas, CNG, LPG and oil gas (manufacturing details not required). Silicones: Synthesis, properties and uses of silicones. Fertilizers: Urea, ammonium sulphate, potassium nitrate, NPK fertilizer, superphosphate, triple superphosphate.
	UNIT –III **Fundamental Concepts in Organic Chemistry** Hybridization: Orbital overlap, hybridization and geometry of CH_4, C_2H_4, C_2H_2 and C_6H_6. Electronic effects: Inductive effect and consequences on Ka and Kb of organic acids and bases, electromeric, mesomeric, hyper conjugation and steric- examples. Reaction mechanisms: Types of reactions-aromaticity (Huckel's rule) aromatic electrophilic substitution; nitration, halogenation, Friedel-Craft's alkylation and acylation. Heterocyclic compounds: Preparation, properties of pyrrole and pyridine.

	UNIT- IV **Thermodynamics and Phase Equilibria** Thermodynamics: Types of systems, reversible and irreversible processes, isothermal and adiabatic processes and spontaneous processes. Statements of first law and second law of thermodynamics. Carnot's cycle and efficiency of heat engine. Entropy and its significance. Free energy change and its importance (no derivation). Conditions for spontaneity in terms of entropy and Gibbs free energy Relationship between Gibbs free energy and entropy. Phase Equilibria: Phase rule definition of terms in it. Applications of phase rule to water system. Two component system Reduced phase rule and its application to a simple eutectic system (Pb-Ag).
	UNIT- V **Analytical Chemistry** Introduction to qualitative and quantitative analysis. Principles of volumetric analysis. Separation and purification techniques extraction, distillation and crystallization. Chromatography: principle and application of column, paper and thin layer chromatography.
Extended Professional Component Not to be included in the external examination question paper	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving. Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended text	1. V. Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition, 2009. 2. S. Vaithyanathan, Text book of Ancillary Chemistry, Priya Publications, Karur, 2006. 3. Arun Bahl, B.S. Bahl, Advanced Organic Chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012. 4. P.L. Soni, H.M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	1	3	2	1
CO2	3	2	2	3	2	2	2
CO3	3	2	3	3	3	2	2
CO4	3	3	3	3	3	2	3

Level of correlation of COs with POs and PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	1	3
CO2	3	2	3	2	3	3	2
CO3	3	3	2	3	2	2	2
CO4	3	2	3	3	2	2	3
Total	12	10	11	10	9	8	10
Average	3	3	3	3	2	2	3

Title of the course	**CHEMISTRY FOR PHYSICAL SCIENCES - II (FOR MATHEMATICS AND PHYSICS STUDENTS)**						
Paper No.	Generic Elective – II						
Category	Generic Elective	Year	I/II	Credits	3	Course code	
		Semester	II/IV				
Instructional hours per week	Lecture	Tutorial		Lab Practice		Total	
	4	-		-		4	
Pre requisites	Chemistry for Physical Sciences – I						

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Explain the fundamental principles of coordination chemistry, carbohydrates, electrochemistry, kinetics, catalysis, and photochemistry.	K1, K2
CO2	Apply chemical theories, equations, and experimental techniques to solve problems related to coordination compounds, electrochemical systems, reaction kinetics, catalysis, and photochemical processes.	K3
CO3	Analyse the structure, properties, mechanisms, and reaction behaviour of coordination compounds, carbohydrates, electrochemical cells, catalytic reactions, and photochemical systems.	K4,

CO4	Evaluate chemical processes and reaction mechanisms critically and develop systematic approaches for applications in coordination chemistry, catalysis, electrochemistry, and photochemistry.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**UNIT- I** **Co-ordination Chemistry and Water Technology** Co-ordination Chemistry: Definition of terms-IUPAC Nomenclature Werner's theory EAN rule Pauling's theory- Postulates Applications to $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[Co(CN)_6]^{3-}$ Chelation Biological role of Haemoglobin and Chlorophyll (elementary idea) Applications in qualitative and quantitative analysis. Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method-Purification techniques-BOD, COD.	
	Unit –II **Carbohydrates and Amino acids** Carbohydrates: Classification, preparation and properties of glucose, fructose and sucrose. Discussion of open chain ring structures of glucose and fructose. Glucose-fructose interconversion. Properties of starch and cellulose. Amino acids: Classification preparation and properties of alanine, preparation of dipeptides using Bergmann method. RNA and DNA (elementary idea only).	
	UNIT- III **Electrochemistry** Galvanic cells Standard hydrogen electrode calomel electrode - standard electrode potentials -electrochemical series. Strong and weak electrolytes ionic product of water pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method - buffer solutions and its biological applications electroplating Nickel and chrome plating-Types of cells-fuel cells-corrosion and its prevention. .	
	UNIT –IV **Kinetics and Catalysis** Order and molecularity. Integrated rate expression for I and II (2A Products) order reactions, Pseudo first order reaction, methods of determining order of a reaction Half-life period - Catalysis - homogeneous and heterogeneous, catalyst used in Contact and Haber's processes. Concept of energy of activation and Arrhenius equation.	

	UNIT -V **Photochemistry** GrothusDrapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield Hydrogen -chloride reaction. Phosphorescence, fluorescence, chemiluminescence photosensitization and photosynthesis (definition with examples)
Extended Professional component, not to be included in the external examination question paper	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended text	1. V. Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition, 2009. 2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006. 3. Arun Bahl, B.S. Bahl, Advanced Organic Chemistry: S.Chand and Company, New Delhi, twenty third edition, 2012. 4. P.L. Soni, H.M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
Reference book	1. P.L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007. 2. R. Puri, L.R. Sharma, M.S. Pathania, Text book Physical Chemistry: Vishal Publishing Co., New Delhi, forty seventh edition, 2018. 3. B.K. Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	2	2	1	1	2
CO2	3	2	2	2	3	2	2
CO3	3	2	3	3	3	2	2
CO4	3	3	3	3	3	2	3

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	3	3
CO2	3	2	2	3	2	1	2
CO3	3	2	3	3	2	2	2
CO4	3	3	3	1	3	2	3
Total	12	10	10	9	9	8	10
Average	3	3	3	2	2	2	3

Title of the course	**CHEMISTRY FOR BIOLOGICAL SCIENCES - I (FOR BOTANY AND ZOOLOGY)**							
Paper No.	Generic Elective – I							
Category	Generic Elective	Year	I/II	Credits	3	Course code		
		Semester	I/III					
Instructional hours per week	Lecture	Tutorial		Lab Practice		Total		
	4	-		-		4		
Pre requisites	Higher secondary chemistry							
COURSE OUTCOMES							COGNITIVE LEVELS	
CO1	Explain the fundamental concepts of chemical bonding, nuclear chemistry, industrial chemistry, organic chemistry, drugs, speciality chemicals, and analytical chemistry.						K1, K2	
CO2	Apply chemical principles, analytical methods, and industrial techniques in the study of bonding, organic reactions, drug chemistry, speciality chemicals, and chemical analysis.						K3	
CO3	Analyse chemical structures, industrial processes, reaction mechanisms, pharmaceutical compounds, and analytical data using scientific reasoning.						K4,	
CO4	Evaluate the effectiveness of industrial and pharmaceutical chemical processes and develop systematic approaches for chemical analysis and application-oriented solutions.						K5, K6	
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create								
Course Outline	**UNIT- I** **Chemical Bonding and Nuclear Chemistry**							

	Chemical Bonding: Molecular Orbital Theory-bonding, antibonding and non-bonding orbitals. M. O diagrams for Hydrogen, Helium, Nitrogen; discussion of bond order and magnetic properties. Nuclear Chemistry: Fundamental particles Isotopes, Isobars, Isotones and Isomers-Differences between chemical reactions and reactions-group displacement law. Nuclear binding energy - mass defect calculations. Nuclear fission and nuclear fusion differences Stellar energy. Applications of radioisotopes - carbon dating, rock dating and medicinal applications.
	Unit –II **Industrial Chemistry** Fuels: Fuel gases: Natural gas, water gas, semi water gas, carbureted water gas, producer gas, CNG, LPG and oil gas (manufacturing details not required). Silicones: Synthesis, properties and uses of silicones. Fertilizers: Urea, ammonium sulphate, potassium nitrate NPK fertilizer, superphosphate, triple superphosphate.
	UNIT –III **Fundamental Concepts in Organic Chemistry** Hybridization: Orbital overlap hybridization and geometry of CH_4, C_2H_4, C_2H_2 and C_6H_6.Polar effects: Inductive effect and consequences on Ka and Kb of organic acids and bases, electromeric, mesomeric, hyper conjugation and steric- examples. Reaction mechanisms: Types of reactions-aromaticity (Huckel's rule) aromatic electrophilic substitution; nitration, halogenation, Friedel-Craft's alkylation and acylation. Heterocyclic compounds: Preparation, properties of pyrrole and pyridine.
	UNIT- IV **Drugs and Speciality Chemicals** Definition, structure and uses: Antibiotics viz., Penicillin, Chloramphenicol and Streptomycin; Anaesthetics viz., Chloroform and ether: Antipyretics viz., aspirin, paracetamol and ibuprofen; Artificial Sweeteners viz., saccharin, Aspartame and cyclamate; Organic Halogen compounds viz., Freon, Teflon
	UNIT –V **Analytical Chemistry** Introduction qualitative and quantitative analysis. Principles of volumetric analysis. Separation and purification techniques: extraction, distillation and crystallization. Chromatography: principle and application of column, paper and thin layer chromatography.
Extended Professional component, not to be included in the	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC others to be solved (To be discussed during the Tutorial hours).

external examination question paper.	
Skill Acquired	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Recommended Text	1. V. Veeraiyan, Text book of Ancillary Chemistry, High mount publishing house, Chennai, first edition, 2009. 2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006. 3. S. Arun Bahl, B. S. Bahl, Advanced Organic Chemistry; S.Chand and Company, New Delhi, twenty third edition, 2012. 4. P. L. Soni, H. M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty 9th edition, 2007.
Reference Book	1. P.L. Soni, Mohan Katyal, Text book of Inorganic chemistry; Sultan Chand and Company, New Delhi, twentieth edition, 2007. 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Textbook Physical Chemistry: Vishal Publishing Co., New Delhi, forty seventh edition, 2018. 3. B.K. Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	2	1	1	1
CO2	3	2	2	3	2	2	2
CO3	3	2	3	3	3	2	2
CO4	3	3	3	3	3	2	3

MSU

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	1	3
CO2	3	2	3	2	3	3	2
CO3	3	2	2	3	3	2	2
CO4	3	3	3	3	1	3	3
Total	12	10	11	10	9	9	10
Average	3	3	3	3	2	2	3

Title of the course	**CHEMISTRY FOR BIOLOGICAL SCIENCES - II (FOR BOTANY AND ZOOLOGY)**						
Paper No.	Generic Elective – II						
Category	Generic Elective	Year	I/II	Credits	3	Course code	
		Semester	II/IV				
Instructional hours per week	Lecture	Tutorial	Lab Practice	Total			
	4	-	-	4			
Pre requisites	Chemistry for biological sciences –I						
COURSE OUTCOMES							COGNITIVE LEVELS
CO1	Explain the fundamental concepts of coordination chemistry, carbohydrates, amino acids, bioelements, electrochemistry, and photochemistry.						K1, K2
CO2	Apply chemical principles and techniques to solve problems related to coordination compounds, biomolecules, electrochemical systems, and photochemical reactions.						K3
CO3	Analyse the structure, properties, reactions, and mechanisms involved in coordination chemistry, biomolecules, electrochemical processes, and photochemical systems.						K4,
CO4	Evaluate the significance and applications of coordination compounds, biomolecules, electrochemical and photochemical processes, and develop systematic approaches for scientific problem solving.						K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create							

Course Outline	**UNIT –I** **Co-ordination Chemistry:** Definition of terms IUPAC Nomenclature Werner's theory EAN rule Pauling's theory-Postulates- Applications to [Ni(CO)4], [Ni(CN)4]2-, [Co(CN)6]3- , Chelation Biological role of Hemoglobin and Chlorophyll (elementary idea) - Applications in qualitative and quantitative analysis. Water Technology: Hardness of water, determination of hardness of water using EDTA method, zeolite method-Purification techniques-BOD and COD.
	Unit- II **Carbohydrates** Classification, preparation and properties of glucose and fructose. Discussion of open chain ring structures of glucose and fructose. Glucose-fructose interconversion. Preparation and properties of sucrose, starch and cellulose.
	Unit- III **Amino acids and Essential elements of biosystem** Amino acids: Classification preparation and properties of alanine, preparation of dipeptides using Bergmann method. Proteins- classification – structure – colour reactions- Biological functions –nucleosides – nucleotides - RNA and DNA -structure. Essentials of trace metals in biological system –Na, Cu, K, Zn, Fe and Mg
	UNIT- IV **Electrochemistry** Galvanic cells - Standard hydrogen electrode calomel electrode - standard electrode potentials -electrochemical series. Strong and weak electrolytes - ionic product of water -pH, pKa, pKb. Conductometric titrations - pH determination by colorimetric method - buffer solutions and its biological applications electroplating - Nickel and chrome plating-Types of cells-fuel cells-corrosion and its prevention.
	UNIT –V **Photochemistry** Grothus Drapper's law and Stark-Einstein's law of photochemical equivalence, Quantum yield Hydrogen -chloride reaction. Phosphorescence, fluorescence, chemiluminescence photosensitization and photosynthesis - definition with examples.
Extended Professional component,,not to be included in the external examination question paper.	Questions related to the above topics, from various competitive examinations UPSC/JAM/TNPSC others to be solved. (To be discussed during the Tutorial hours)
Skills acquired from this	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.

course	
Recommended Text	1. V. Veeraiyan, Textbook of Ancillary Chemistry; High mount publishing house, Chennai, first edition, 2009. 2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya Publications, Karur, 2006. 3. Arun Bahl, B.S. Bahl, Advanced Organic Chemistry: S. Chand and Company, New Delhi, twenty third edition, 2012. 4. P.L. Soni, H.M. Chawla, Text Book of Organic Chemistry; Sultan Chand & sons, New Delhi, twenty ninth edition, 2007.
Reference Books	1. P.L. Soni, Mohan Katyal, Text book of Inorganic chemistry. Sultan Chand and Company, New Delhi, twentieth edition, 2007. 2. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical Chemistry, Vishal Publishing Co., New Delhi, forty seventh edition, 2018. 3. B. K. Sharma, Industrial Chemistry; GOEL publishing house, Meerut, sixteenth edition, 2014.

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	2	1	1	1
CO2	3	2	2	2	3	2	2
CO3	3	2	3	3	3	2	2
CO4	3	3	3	3	3	2	3

Level of correlation of COs with POs and PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	3	3
CO2	3	2	2	3	2	2	2
CO3	3	2	2	3	3	2	2
CO4	3	3	3	1	2	1	3
Total	12	10	10	9	9	8	10
Average	3	3	3	2	2	2	3

<table>
<tr><td>Title of the course</td><td colspan="8">CHEMISTRY PRACTICAL FOR PHYSICAL AND BIOLOGICAL SCIENCES

<u>INORGANIC VOLUMETRIC ANALYSIS</u></td></tr>
<tr><td>Paper No.</td><td colspan="8">Generic Elective practical IP/IIIP</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Generic Elective</td><td>Year</td><td>I/II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course code</td><td rowspan="2"></td></tr>
<tr><td>Semester</td><td>I/III</td></tr>
<tr><td rowspan="2">Instructional hours per week</td><td>Lecture</td><td colspan="2">Tutorial</td><td colspan="2">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td colspan="2">-</td><td colspan="2">2</td><td colspan="2">2</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Higher secondary chemistry</td></tr>
<tr><td colspan="2">COURSE OUTCOMES</td><td colspan="7">COGNITIVE LEVELS</td></tr>
<tr><td>CO1</td><td colspan="6">Recall and explain the principles, reactions, indicators, standard solutions and experimental procedures involved in acid–base, permanganometric and complexometric titrations.</td><td>K1, K2</td></tr>
<tr><td>CO2</td><td colspan="6">Apply volumetric analysis techniques for the quantitative estimation of analytes using acid–base, redox and complexometric titration methods.</td><td>K3</td></tr>
<tr><td>CO3</td><td colspan="6">Analyze titration data, identify end points, calculate concentration of analytes and interpret sources of experimental errors in volumetric analysis.</td><td>K4</td></tr>
<tr><td>CO4</td><td colspan="6">Evaluate the accuracy and precision of titration methods and design suitable experimental procedures for estimation of inorganic analytes using volumetric techniques.</td><td>K5, K6</td></tr>
<tr><td colspan="8">K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create</td></tr>
<tr><td>Course Outline</td><td colspan="8">VOLUMETRIC ANALYSIS
1. Estimation of sodium hydroxide using standard sodium carbonate.
2. Estimation of hydrochloric acid using standard oxalic acid.
3. Estimation of ferrous sulphate using standard mohrs salt.
4. Estimation of oxalic acid using standard ferrous sulphate.
5. Estimation of potassium permanganate using standard sodium hydroxide.
6. Estimation of magnesium using EDTA.
7. Estimation of ferrous ion using diphenyl amine as indicator.</td></tr>
<tr><td>Reference Book</td><td colspan="8">V. Venkateswaran, R. Veerasamy, A.R. Kulandaivelu, Basic Principles of Practical Chemistry; Sultan Chand & sons, Second edition, 1997.</td></tr>
</table>

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	0	0
CO2	3	3	2	3	2	1	1
CO3	2	3	2	3	1	1	1
CO4	2	3	3	3	2	2	2

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	2	2	2
CO2	3	3	3	3	2	3	3
CO3	3	3	3	2	3	2	3
CO4	2	2	3	2	3	3	2
Total	11	10	11	9	10	10	10
Average	3	3	3	2	3	3	3

Title of the Course	**CHEMISTRY PRACTICAL FOR PHYSICAL AND BIOLOGICAL SCIENCES** **QUALITATIVE INORGANIC ANALYSIS**						
Paper No.	Generic Elective practical –IIP/IVP						
Category	Generic Elective	Year	I/II	Credits	2	Course Code	
		Semester	II/IV				
Instructional hours per Week	Lecture	Tutorial	Lab Practice			Total	
	-	-	2			2	
Pre requisites	General Chemistry						

COURSE OUTCOMES		COGNITIVE LEVELS
CO1	Recall and explain the principles, reactions, group reagents and procedures involved in the systematic qualitative analysis of simple inorganic salts containing one anion and one cation.	K1, K2
CO2	Apply qualitative analytical techniques to identify acidic and basic radicals present in simple inorganic salts through systematic experimentation.	K3

CO3	Analyze experimental observations, infer the presence of specific anions and cations and interpret the chemical reactions involved in qualitative analysis.	K4,
CO4	Evaluate the accuracy and reliability of analytical results and design suitable systematic procedures for the identification of inorganic salts.	K5, K6
K 1 –Remember K 2 – Understand K 3 - Apply K 4 – Analyze K 5 –Evaluate K 6 – Create		
Course Outline	**Semi-Micro Qualitative Analysis** 1.Analysis of simple acid radicals: Carbonate, sulphide, sulphate, chloride, nitrate. 2. Analysis of interfering acid radicals: Fluoride, oxalate, borate, phosphate. 3. Elimination of interfering acid radicals and identifying the group of basic radicals 4. Analysis of basic radicals (group wise): Lead, copper, cadmium, nickel, cobalt, barium, ammonium. 5. Analysis of a simple salt containing one cation and one anion.	
Skills acquired from this course	Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.	
Recommended Text	**Reference Books:** V. Venkateswaran, R. Veera swamy and A. R. Kulandivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, New Delhi, second edition, 1997.	
Website and e-learning source	https://www.vlab.co.in/broad-area-chemical-sciences	

MSU

Level of correlation of COs with POs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	0	2	2	2
CO2	3	2	2	3	2	3	2
CO3	2	1	3	3	3	3	1
CO4	2	2	3	3	3	2	2

Level of correlation of COs with PSOs.

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	2	1	3
CO2	3	3	2	3	3	3	2
CO3	3	3	3	3	2	2	3
CO4	2	2	3	2	3	3	2
Total	11	10	10	10	10	9	10
Average	3	3	3	3	3	2	3

MSU