UNIVERITY OF RAJASTHAN

JAIPUR-302004

THREE/FOUR-YEAR UNDERGRADUATE PROGRAMME

Name of Faculty	**Science**
Name of Discipline	**Chemistry**
Type of Discipline	**Major**
List of Programme offered as Minor Discipline	**-NA-**
Offered to Non-Collegiate Students	**-Yes**

Programme: UG0802/03 – Three/Four Year Bachelor of Science

I & II Semester

(Syllabus as per NEP-2020 and Choice Based Credit System)

(Academic Year 2025-26 onwards)

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0802/03 – Three/Four Year Bachelor of Science								
S. No.	Level	Semester	Type	Chemistry	Credits			
				Course Title	L	T	P	Total
1.	5	I	MJR	UG0802/03 – CHM-51T-101 – Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.	4	0	0	4
2.	5	I	MJR	UG0802/03– CHM-51P-102 – Practical I	0	0	2	2
3.	5	II	MJR	UG0802/03 – CHM-52T-103 – Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.	4	0	0	4
4.	5	II	MJR	UG0802/03 – CHM-52P-104 – Practical II	0	0	2	2
5.	6	III	MJR	UG0802/03 – CHM-63T-201 –	4	0	0	4
6.	6	III	MJR	UG0802/03 – CHM-63P-202 – Practical III	0	0	2	2
7.	6	IV	MJR	UG0802/03 – CHM-64T-203 –	4	0	0	4
8.	6	IV	MJR	UG0802/03 – CHM-64P-204 – Practical IV	0	0	2	2
9.	7	V	MJR	UG0802/03 – CHM-75T-301 --Hard & Soft Acids and Bases, Transition metal complexes, Spectroscopy, Organosulphur compounds, Synthetic Polymers, Drugs & Dyes. Electrochemistry.	4	0	0	4
10.	7	V	MJR	UG0802/03 – CHM-75P-302 – Practical V	0	0	2	2
11.	7	VI	MJR	UG0802/03 –CHM-76T-303 – Bioinorganic chemistry, Organometallic chemistry, Heterocyclic chemistry, Carbohydrates, Spectroscopy, Quantum mechanics and MOT	4	0	0	4
12.	7	VI	MJR	UG0802/03 – CHM-76P-304 – Practical VI	0	0	2	2
13.	8	VII	MJR	UG0802/03 – CHM-87T-401 –	4	0	0	4
14.	8	VII	MJR	UG0802/03 – CHM-87P-402 – Practical VII	0	0	2	2
15.	8	VIII	MJR	UG0802/03 – CHM-88T-403 –	4	0	0	4
16.	8	VIII	MJR	UG0802/03 – CHM-88P-404 – Practical VIII	0	0	2	2

PROGRAMME PREREQUISITES/ELIGIBILITY

12th standard pass in science from CBSE, RBSE or a recognized board of education.

PROGRAMME OUTCOMES (POs)

1. **Conceptual knowledge of chemical science:** Students will get acquainted with the conceptual knowledge of chemical science which will help them to understand the subject and it will be beneficial in long run.
2. **Training to manage unusual and unexpected incidents/disasters:** The knowledge of chemical science will help them to deal with unusual incidents in the neighborhood. Sudden explosion by chemicals and excessive misuse of unwanted substances can be managed with basic knowledge of chemistry as well as environmental pollution may be controlled by the students by spreading awareness in the society about the harmful pollutants viz; plastic, pesticides, harmful smog, unused drugs etc.

3. **Laboratory Experimental Skills:** As we know the fact that trials are an essential part of an exploration in our life therefore the students will gain practical experience by conducting experiments, using laboratory instruments and apparatus.
4. **Employment opportunities:** Students will acquire employment in the various national and private R & D sectors such as:
   The students with the strong chemistry background can get jobs in chemical and related industries viz. Agrochemicals, Metallurgical, Fertilizer, Biofertilizer, Textile, Food, Ceramics, Cement, Petrochemicals, Pesticides, Plastics, Polymers, etc.
   The students can find opportunities in Pharmaceutical companies, ForensiLab,etc. Petroleum, Soil Testing Labs, Environment consulting firms and other sectors such as Analytical Chemist, Chemical Product Officer, Radiologist and Toxicologist.
5. **Integrated M. Sc-Ph.D courses at prestigious institutions:**
   After completing this bachelor's degree course, students can get engaged in integrated M,Sc- Ph D courses or can get Master's degree in various interdisciplinary fields at prestigious institutions like CSIR, IISc, IITs, NCL (national chemical laboratories), IISERs, NISER etc.

Examination Scheme:

- **1 Credit = 25 marks for examination/evaluation.**
- **For Regular Students:**
  - There will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components - Continuous assessment (20% weightage) and (**End of Semester Examination**) EoSE (80% weightage).
  - 75% Attendance is mandatory for appearing in EoSE.
  - To appear in the EoSE examination of a course/subject student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.
  - Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a C grade in the **CA (Continuous Assessment)** and EoSE examination of a Course/Subject.
- **In case of the Non-Collegiate Students**:
  - There will be no Continuous Assessment and credit points in a Course/Subject will be assigned only if, the Non-Collegiate Student obtains at least a C grade in the EoSE examination of a Course/Subject.

Examination scheme for Continuous assessment (CA)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory + Practical)	SEC	VAC
	Max Internal Marks			30	20	20	10	10	10	10	10
1	Mid-term Exam	50%		15	10	10	5	5	5	5	5
2	Assignment	25%		7.5	5	5	5	2.5	2.5	2.5	2.5
3	Attendance	25%		7.5	5	5	5	2.5	2.5	2.5	2.5
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75 – 80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80 – 85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

Note:

1. Continuous assessment will be the sole responsibility of the teacher concerned (under the heading assignment, interactive sessions/ group discussion among students may be conducted by the concerned teacher / PPT for selective topics may be assigned by the teacher at college level).
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

I – Semester

Examination Scheme for EoSE

- **CA – Continuous Assessment**
- **EoSE – End of Semester Examination**

For Regular Students

Type of Examination	Course Code / Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	CHM-51T-101 – Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Practical	CHM-51P-102 – Practical I	CA	1 Hr.	CA	10	CA	4
		EoSE	4 Hrs.	EoSE	40	EoSE	16

The question paper in EoSE (End of Semester Examination) will consist of two parts A & B.

PART – A: 20 Marks

Part A will be compulsory, consisting of 10 very short answer-type questions (with a limit of 20 words) covering the entire syllabus, carrying two marks for each.

PART – B: 60 Marks

Part B of the question paper will have four questions with internal choice comprising of question number 2-5 which will be divided into four units. There will be one question with internal choice from each unit. Each question will carry 15 marks

For Non-Collegiate Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination	Maximum Marks	Minimum Marks
Theory	**CHM-51T-101 - Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.**	**3 Hrs.**	**100**	**40**
Practical	**CHM-51P-102 – Practical I**	**4 Hrs.**	**50**	**20**

The question paper in EoSE (End of Semester Examination) will consist of two parts A & B

PART – A: 20 Marks

Part A will be compulsory, consisting of 10 very short answer-type questions (with a limit of 20 words) covering the entire syllabus, carrying two marks for each.

PART – A: 80 Marks

Part B of the question paper will have four questions with internal choice comprising of question number 2-5 which will be divided into four units. There will be one question with internal choice from each unit. Each question will carry 20 marks.

Syllabus

I – Semester – [Chemistry]

[UG0802/03]-[CHM-51T-101]- Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.

[UG0802/03]-[CHM-51P-102]- PRACTICAL – I

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
I	CHM-51T-101	Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.				5	4
I	CHM-51P-102	PRACTICAL-I				5	2
Level of Course	Type of the Course	Credit Distribution			Offered to NC Students	Course Delivery Method	
		Theory	Practical	Total			
5	Major	4	2	6	Yes	Through Lecture, Sixty (60) Lectures	Class room Teaching/Power-Point (PPT)
List of Programme Codes in which offered as Minor Discipline		-NA -					
Prerequisites/Eligibility		12th standard pass in science from CBSE, RBSE or a recognized board of education.					
Course Objectives:		The main aim of this course is to provide students with a theoretical and conceptual understanding of s-, p-block elements chemistry, noble gases, nuclear chemistry and the fundamental concepts of organic chemistry with their reaction mechanisms, generation and stability of various intermediates, including stereochemistry. The objective of this course is to understand the basic concepts of mathematics and to get knowledge in the chemical kinetics of reactions. Moreover, the laboratory course is further designed to provide students with practical experience in basic qualitative analytical techniques including basic laboratory techniques.					

Detailed Syllabus

Semester-I – [Chemistry]

UG0802/03 CHM-51T-101 (4 Hrs./week)	**Chemistry of s & p-block elements. Noble Gases, Nuclear Chemistry, Fundamentals of Organic Chemistry, Stereochemistry, Mathematical Concepts and Chemical Kinetics.**

Unit-I

Periodicity of s and p-block elements:
Effective nuclear charge, Shielding or screening effect, Slater rules, Variation of effective nuclear charge in periodic table. Atomic radii (van der Waals), Ionic and crystal radii, Covalent radii (octahedral and tetrahedral). Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, Trends of electron gain enthalpy. Electronegativity, Pauling's/Mulliken's/Allred-Rochow's and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, Partial charge, Hybridization, Group electronegativity. Sanderson's electron density ratio.

Periodicity in properties of p-block elements with special reference to atomic and ionic radii, Ionization energy, Electron-affinity, Electronegativity, Diagonal relationship, Catenation.

s-Block Elements: Comparative study of properties of alkali and alkaline earth metals, Diagonal relationships, Salient features of hydrides, Solvation and complexation tendencies including their functions in biosystems, An introduction to alkyls and aryls.

Unit-II

Some Important Compounds of p-block Elements: Hydrides of boron, Diborane and higher boranes, Borazine, Borohydrides, Fullerenes, Carbides, Fluorocarbons, Silicates (structural principle), Tetrasulphurtetranitride, Basic properties of halogens, Interhalogens and polyhalides.

Chemistry of Noble Gases: Chemical properties of the noble gases, Chemistry of Xenon, Structure and bonding in Xenon compounds.

Nuclear Chemistry: Fundamental particles of nucleus (nucleons), concept of nuclides and its representation, Isotopes, Isobars and Isotones (with specific examples), forces operating between nucleons (n-n, p-p & n-p), Qualitative idea of stability of nucleus (n/p ratio).
Radiochemistry: Natural and artificial radioactivity, Radioactive disintegration series, Radioactive displacement law, Radioactivity decay rates, Half-life and average life, Nuclear binding energy, Mass defect and calculation of defect and binding energy, Nuclear reactions, Spallation, Nuclear fission and fusion. Brief discussion on atom bomb, Nuclear reactor and Hydrogen atom.

15 Lectures

Unit-III

Fundamentals of organic chemistry: Organic Compounds: Classification and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, Electromeric, Resonance and mesomeric effects, Hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic bond fission with suitable examples. Curly arrow rules, Formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity.

Stereochemistry of Organic Compounds: Concept of isomerism, Types of isomerism, Difference between configuration and conformation, Flying wedge and Fischer projection formulae.

Optical Isomerism: Elements of symmetry, Molecular chirality, Enantiomers, Stereogenic centre, Optical activity. Properties of enantiomers, Chiral and achiral molecules with two stereogenic centres. Diastereomers, Threo and erythro isomers, Meso compounds. Resolution of enantiomers. Inversion, Retention and racemization (with examples).

Relative and absolute configuration, Sequence rules, D/L and R/S systems of nomenclature.

Geometrical Isomerism: Determination of configuration of geometric isomers - cis/trans and E/Z systems of nomenclature. Geometrical isomerism in oximes and alicyclic compounds.

Conformational Isomerism: Newman projection and Sawhorse formulae, Conformational analysis of ethane, *n*-butane and cyclohexane.

Unit-IV

Mathematical Concepts:

Logarithmic relations, Curve sketching, Linear graphs and calculations of slopes, Differentiation of functions like: kx, e^{x}, x^{n}, $sin\, x$ and $log\, x$. maxima and minima, Partial differentiation and Euler's reciprocity relations, Integration of some useful/relevant functions. Permutations and combinations, Factorials, Probability, Matrices and Determinant.

Chemical Kinetics:

Chemical kinetics and its scope, Rate of a reaction, Factors influencing the rate of a reaction: concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates, Mathematical characteristics of simple chemical reactions - zero order, first order, second order and pseudo-order; Half-life and mean-life. Determination of the order of reaction - differential method, Method of integration, Method of half-life period and isolation method.

Radioactive decay as a first order phenomenon.

Experimental methods of chemical kinetics: Conductometric, Potentiometric, Optical methods: polarimetry and spectrophotometric method. Theories of chemical kinetics. Effect of temperature on rate of reaction, Arrhenius equation, Concept of activation energy.

Simple collision theory based on hard sphere model transition state theory (equilibrium hypothesis). Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

15 Lectures

Suggested Books and References:

1. Concise Inorganic Chemistry by J.D. Lee, Wiley.
2. Inorganic Chemistry by Catherine E. Housecroft and Alan G. Sharpe, Pearson.
3. Selected Topics in Inorganic Chemistry by Wahid U. Malik, G. D. Tuli and R. D. Madan, S. Chand, New Delhi.
4. Advanced Inorganic Chemistry: Volume I & II by Satya Prakash, G. D. Tuli, S. K. Basu and R. D. Madan, S. Chand, New Delhi.
5. Inorganic Solids – Introduction to Concepts in Solid-state Structural Chemistry by D. M. Adams, John Wiley, London.
6. Principles of Inorganic Chemistry by Puri, Sharma & Kalia, Vishal Publishing Co.
7. Essentials of Nuclear Chemistry by H.J. Arnikar, New Age International Publishers.
8. Organic Chemistry by I. L. Finar**,** Pearson.
9. Organic Chemistry by R.T**.** Morrison, R.N. Boyd & S.K. Bhattacharjee, Pearson.
10. Stereochemistry conformation and Mechanism by P.S. Kalsi, New Age International Publishers.
11. Stereochemistry of Organic Compounds by V. K. Ahluwalia, Springer.
12. Chemical Kinetics by Keith J. Laidler, Pearson Education.
13. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma & M. S. Pathania, Vishal Publishing Co.
14. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
15. Physical Chemistry by W. Atkins, Oxford University Press.
16. Physical Chemistry by R. J. Silby and R. A. Alberty, John Wiley & Sons.
17. Physical Chemistry by G.M. Barrow, Tata McGraw-Hill.
18. A Textbook of Physical Chemistry: (Volume I) by K. L. Kapoor, Macmillan India Ltd.

Suggested E-resources:

All the above suggested books are available as e- books.

Online Lecture Notes and Course Materials:

All prescribed courses are available in the form of e-books, Adobe Acrobat documents (PDF), web pages etc.

SYLLABUS

CHM-51P-102: Practical – I (4 Hrs./week)

Inorganic Chemistry **10 marks**

1. **Volumetric Analysis**
   (a) Estimation of hardness of water by EDTA.
   (b) Estimation of ferrous/ferric ions by dichromate/permanganate method.
   (c) Estimation of copper using thiosulphate by iodometric method.
   (d) Determination of quantity of acetic acid in commercial vinegar using standard NaOH solution.
   (e) Determination of alkali content in antacid tablet using standard HCl solution.
   (f) Estimation of calcium content in chalk as calcium oxalate by permanganometery.

Organic Chemistry **10 marks**

2. **A. Laboratory Techniques** **3 marks**
   (a) Determination of melting point (naphthalene, benzoic acid, urea etc.); boiling point (methanol, ethanol, cyclohexane, etc.); mixed melting point (urea-cinnamic acid) using Thiele's tube.
   (b) Crystallization of phthalic acid and benzoic acid from hot water, acetanilide from boiling water, naphthalene from ethanol. Sublimation of naphthalene, camphor etc.

   B. Qualitative Analysis **7 marks**
   Identification of functional groups (unsaturation, phenolic, alcoholic, carboxylic, carbonyl, ester, carbohydrate, amine, amide, nitro, etc.) in simple organic compounds (solids or liquids) through element detection (N, S and halogens).

Physical Chemistry **10 marks**

3. **Viscosity and Surface Tension:**
   (a) To determine the viscosity/surface tension of a pure liquid (alcohol etc.) at room temperature. (Using the Ostwald Viscometer/Stalagmometer, respectively.).
   (b) To determine the percentage composition of a given binary mixture (acetone and ethyl methyl ketone) by surface tension method.
   (c) To determine the percentage composition of a given binary mixture (non- interacting systems) by viscosity method.
   (d) To determine the viscosity of amyl alcohol in water at different concentrations (hange in viscosity due to intermolecular interactions and calculate the excess viscosity of these solutions.

4. **Viva voce** **5 marks**

5. **Practical Record** **5 marks**

Suggested Books and References:

1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel, Prentice Hall.
2. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
3. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
4. Advanced Practical Organic Chemistry by N. K. Vishnoi, Vikas Publishing House Pvt Ltd.
5. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
6. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International, N
7. Advanced Practical Organic Chemistry J. B Yadav, Goel Publishing House.
8. Practical Physical Chemistry, by B. D Khosla, S. Chand & Company.

Suggested E-resources:

All the above suggested books are available as e- books.

Online Lecture Notes and Course Materials:

All prescribed courses are available in digital form in the form of e-books, Adobe Acrobat documents (PDF), web pages etc.

Course Learning Outcomes:

By the end of this course, students will acquire clear understanding of various concepts related to chemistry of s & p-block elements, noble gases, nuclear chemistry, fundamentals of organic chemistry, classifying the molecules as chiral or achiral, determining the D/L and R/S nomenclature of stereoisomers and identifying the formation of racemic mixture or optically active compounds, mathematical concepts along with chemical kinetics of reactions. Students will also have practical experience in basic laboratory techniques including determination of various physical properties of substances, crystallization and preparation of standard solutions of different concentrations along with identification of functional groups in organic compounds,.

Syllabus

II – Semester – [Chemistry]

Examination Scheme for
CA – Continuous Assessment
EoSE - End of Semester Examination

For Regular Students –

Type of Examination	Course Code / Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	CHM-52T-103 – Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.	CA	1 Hr.	CA	20	CA	8
		EoSE	3 Hrs.	EoSE	80	EoSE	32
Practical	CHM-52P-104 – Practical II	CA	1 Hr.	CA	10	CA	4
		EoSE	4 Hrs.	EoSE	40	EoSE	16

The question paper in EoSE (End of Semester Examination) will consist of two parts A & B.

PART – A: 20 Marks

Part A will be compulsory, consisting of 10 very short answer-type questions (with a limit of 20 words) covering the entire syllabus, carrying two marks for each.

PART – B: 60 Marks

Part B of the question paper will have four questions with internal choice comprising of question number 2-5 which will be divided into four units. There will be one question with internal choice from each unit. Each question will carry 15 marks.

For Non-Collegiate Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination	Maximum Marks	Minimum Marks
Theory	**CHM-52T-103 – Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.**	**3 Hrs.**	**100**	**40**
Practical	**CHM-52P-104 Practical II**	**4 Hrs.**	**50**	**20**

The question paper in EoSE □□End of Semester Examination) will consist of two parts A & B

PART – A: 20 Marks

Part A will be compulsory, consisting of 10 very short answer-type questions (with a limit of 20 words) covering the entire syllabus, carrying two marks for each.

PART – A: 80 Marks

Part B of the question paper will have four questions with internal choice comprising of question number 2-5 which will be divided into four units. There will be one question with internal choice from each unit. Each question will carry 20 marks.

Syllabus

II – Semester – [Chemistry]

[UG0802/03]-[CHM-52T-103]- Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.

[UG0802/03]-[CHM-52P-104]- PRACTICAL-II

II – Semester – [Chemistry]

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
II	CHM-52T-103	Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.				5	4
II	CHM-52P-104	PRACTICAL-II				5	2
Level of Course	Type of the Course	Credit Distribution			Offered to NC Students	Course Delivery Method	
		Theory	Practical	Total			
5	Major	4	2	6	Yes	Through Lecture, Sixty (60) Lectures	Class room Teaching/Power-Point (PPT)
List of Programme Codes in which offered as Minor Discipline		NA					
Prerequisites/Eligibility		Every student automatically promoted from I to II semester after the I-Semester EoSE.					
Course Objectives:		The main objective of this course is to provide students with a theoretical and conceptual understanding of chemical & metallic bonding of compounds. Structure and reactivity of aromatic & aliphatic hydrocarbons (alkanes, alkenes, cycloalkenes, dienes and alkynes) including alkyl & aryl halides chemistry are also included to enrich knowledge in the fields. Further, our aim is to explain the various states of matter, viz. solid, liquid and gases in this curriculum. The laboratory course is designed to provide practical skill and knowledge to synthesize various organic derivatives including chromatographic techniques. Moreover, qualitative analytical techniques like identification of cations and anions in inorganic mixtures with special anions combinations along with quantitative analysis to determine the order, molecularity and kinetic parameters of reactions are also incorporated to enrich knowledge in the practical field.					

Detailed Syllabus

II – Semester – [Chemistry]

CHM-52T-103-Chemical Bonding, Reactions Mechanism, Aromatic & Aliphatic hydrocarbons, Alkyl & Aryl Halides, States of Matter.

Unit-I

Ionic Solids: Ionic structures, Radius ratio effect and coordination number, Limitations of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and solubility of ionic solids, Polarizing power and polarisability of ions, Fajan's rule.

Covalent Bond: Valence bond theory and its limitations, Directional characteristics and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, CIF_3, ICl_2, H_2O.

Molecular Orbital Theory: Homonuclear and heteronuclear (CO and NO) diatomic molecules. Multicenter bonding in electron deficient molecules, Bond strength and bond energy, Percentage ionic character from dipole moment and electronegativity difference.

Metallic bond: Free electron, Valence bond and band theories.

Weak Interactions: Hydrogen bonding, Van der Waals forces.

15 Lecture

Unit-II

Mechanism of Organic Reactions:

Reaction intermediates: Types, shapes and relative stability; Carbocations, Carbanions, Free radicals, Carbenes, Nitrenes and Benzyne (Arenes). Types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions. Markovnikov rule, Anti-Markovnikov rule, Saytzeff's rule and Hofmann elimination. Energy considerations. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

Aliphatic Hydrocarbon

Alkanes and Cycloalkanes: Free radical halogenation of Alkanes: mechanism, orientation, reactivity and selectivity. Cycloalkanes - nomenclature, methods of formation, chemical reactions. Baeyer's strain theory and its limitations. Theory of strain-less rings.

Alkenes, Cycloalkenes, Dienes and Alkynes: Relative stabilities of alkenes. Chemical reactions of alkenes - hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis and oxidation with $KMnO_4$, Polymerization of alkenes, Substitution at the allylic and vinylic positions of alkenes.

Classification and nomenclature of isolated, conjugated and cumulated dienes. Structure of allenes and butadiene. Methods of formation, properties and chemical reactions - 1,2- and 1,4-additions, Diels-Alder reaction and polymerization reactions.

Structure and bonding of alkynes, Synthetic methods, Chemical reactions - acidity of alkynes, Mechanism of electrophilic and nucleophilic addition reactions: hydroboration-oxidation, metal-ammonia reduction, oxidation and polymerization.

15 Lecture

Unit-III

Arenes and Aromaticity: Nomenclature of benzene derivatives: The aryl group, aromatic nucleus and side chain, Structure of benzene: molecular formula and kekule structure, Stability and carbon-carbon bond lengths of benzene, Resonance structure, MO diagram.

Aromaticity: Huckel's rule, aromatic ions-three to eight membered.

Aromatic electrophilic substitution: General pattern of the mechanism, role of sigma and pi complexes, Mechanism of nitration, halogenation, sulphonation, mercuration, chloromethylation and Friedel crafts reactions, Energy profile diagrams, Activating and deactivating substituents, Directive influence, orientation and ortho/para ratio. Side chain reactions of benzene derivatives, Birch reduction.

Alkyl Halides: Synthetic methods of alkyl halides, Chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides S_N2 and S_N1 reactions with energy profile diagrams.

Polyhalogen compounds: Chloroform, Carbon tetrachloride

Aryl Halides: Methods of formation of aryl halides, Nuclear and side chain reactions, The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions, Relative reactivities of alkyl, allyl, vinyl and aryl halides.

Unit- IV

States of matter

Gaseous States: Postulates of kinetic theory of gases, Deviation from ideal behavior, Van der Waals equation of state. **Critical Phenomenon:** PV isotherms of real gases, Continuity of states, the isotherms of Van der Waals equation, Relationship between critical constants and van der Waals constants, The law of corresponding states, Reduced equation of state.

Molecular Velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, Collision number, Mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect.)

Liquid State: Intermolecular forces, Structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of somatic, nematic and cholesteric phases. Thermography and seven segment cells.

Solid State: Definition of space lattice, Unit cell.

Laws of crystallography- (i) Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

Basic concept of X-ray diffraction by crystals. Derivation of Bragg's equation. Determination of crystal structure of $NaCl$ and $CsCl$ (Laue's method and powder method.), Band theory of solids, Defects in solids.

15 Lectures

Suggested Books and References:

1. Concise Inorganic Chemistry by J.D. Lee, Wiley.
2. Inorganic Chemistry: Principles of Structure and Reactivity by Ellen A. Keiter, James E. Huheey and Richard L. Keiter, Pearson.
3. Organic Chemistry by S. S. Gupta, Oxford University Press.
4. Organic Reaction Mechanisms by V. K. Ahluwalia and Rakesh Kumar Parashar, Narosa Publishing House, New Delhi.
5. Organic Chemistry – Reactions and Reagents: Covering Complete Theoretical Organic Chemistry by O. P Agarwal, Goel Publishing House, Meerut.
6. Organic Chemistry by R. T. Morrison and R. N. Boyed, Prentice Hall.
7. Organic Chemistry by I. L. Finar (Vol. I & II), ELBS.
8. Advanced Organic Chemistry by A. Bahl and B**. S.** Bahl, S. Chand.
9. Modera Organic Chemistry by M.K. Jain and S. C. Sharma, Vishal Publishing Co.
10. March's Advanced Organic Chemistry: Reactions,
11. Mechanisms and Structure by J. March and M. B. Smith, Wiley.Mechanism in Organic Chemistry by Peter Sykes, Pearson Education.
12. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, Vishal Publishing Co.
13. Advanced Physical Chemistry by Gurdeep Raj, Goel Publishing House.
14. A Textbook of Physical Chemistry by K. L. Kapoor (Volume 5), Macmillan India Ltd.
15. Chemical Kinetics and Reaction Dynamics by Santosh K. Upadhyay, Springer (Anamaya Publishers, New Delhi, India).

Suggested E-resources:

All the above suggested books are **available as e- books**.

Online Lecture Notes and Course Materials:

All prescribed courses are available in the form of **e-books**, Adobe Acrobat documents **(PDF**), **web pages**

Syllabus

CHM-52P-104: Practical II — 4 Hrs./week

Inorganic Chemistry — **10 marks**

1. **Qualitative Analysis**
   Separation and identification of six radicals (three cations and three anions) in the given inorganic mixture including special combinations of anions.

Organic Chemistry — **10 marks**

2. (a) Synthesis of semi carbazones of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
   (b) Synthesis of 2,4-dinitrophenylhyrazones of any aldehyde /ketone.
   (c) Synthesis of Coumarin through salicylaldehyde.
   (d) Synthesis of 3,5- dinitro benzoic acid using benzoic acid and nitrating reagent

   OR

   (a) Chromatography separation of the active ingredients of plants (spinach etc.), flowers and juices by Paper/Thin layer chromatography (TLC).
   (b) Separation and identification of the monosaccharides in the given mixture by Paper/Thin layer chromatography (TLC) and reporting the R_f values.
   (c) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography.

Physical Chemistry — **10 marks**

3. **Chemical Kinetics:**
   (a) To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
   (b) To study the effect of acid strength on the hydrolysis of an ester.
   (c) To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.
   (d) To study the oxidation of iodide ions by H_2O_2 as an iodine clock reaction.
   (e) To study the decomposition of H_2O_2 catalyzed by iodide ions.
   (f) To study the kinetics of reaction between acetone and iodine in presence of an acids.

4. **Viva voce** — **5 marks**

5. **Practical Record** — **5 marks**

Suggested Books and References:

1. Vogel's Qualitative Inorganic Analysis, A. I. Vogel Prentice Hall.
2. Vogel's Quantitative Inorganic Analysis Including Elementary Instrumental Analysis, ELBS.
3. Vogel's Textbook of Quantitative Chemical Analysis, A. I. Vogel, Pearson Education Ltd.
4. Advanced Practical Organic Chemistry by N. K. Vishnoi, Vikas Publishing House Pvt Ltd.
5. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, V. K Ahluwalia. Universities Press, Hyderabad.
6. Laboratory Techniques in Organic Chemistry by V. K Ahluwalia, I K International, N
7. Advanced Practical Organic Chemistry J. B Yadav, Goel Publishing House.
8. Practical Physical Chemistry, by B. D Khosla, S. Chand & Company.
9. Advanced Practical Organic Chemistry by Amit Arora, Discovery Publishing House, New Delhi.

Suggested E-resources:

All the above suggested books are available as e- books.

Online Lecture Notes and Course Materials:

All prescribed courses are available in digital form in the form of e-books, Adobe Acrobat documents (PDF), web pages etc.

Course Learning Outcomes:

Once completed course, students will acquire a clear understanding of chemical bonding, organic reactions mechanisms for various fundamental reactions of aliphatic & aromatic hydrocarbons, alkyl & aryl halides along with states of matters.

They will acquire practical skill and knowledge in qualitative analytical techniques, viz. identification of cations and anions in inorganic mixtures with special anions combinations along with synthetic route of various organic derivatives including chromatographic techniques. Students can achieve practical knowledge about order, molecularity and kinetic parameters of reactions.