ST. JOSEPH'S COLLEGE, DEVAGIRI
(AUTONOMOUS)

B.Sc. DEGREE PROGRAMME
IN
CHEMISTRY

SCHEME AND SYLLABUS OF

CORE COURSES, COMPLEMENTARY COURSES &

OPEN COURSES

(Effective from 2015 ADMISSION)

UNDERGRADUATE PROGRAMME IN CHEMISTRY

PREFACE

With the pace that the world keeps and the speed with which technology advances, an understanding of science is inevitable in our day-to-day life. To make the study of science interesting and enjoyable, the creation of a scientific temper in society is a must which could be achieved through proper education and guidance. An effective science education can be imparted at the undergraduate level only by revamping the curriculum according to the needs and developments of the modern society from time to time. To achieve this goal, the curriculum should be restructured by giving emphasis on various aspects such as the creativity of students, knowledge of current developments in the discipline, awareness of environmental impacts due to the development of science and technology, and the skills essential for handling equipments and instruments in laboratories and industries.

Chemistry, being an experimental science, demands testing theories through practical laboratory experiences for a thorough understanding of the subject. Nowadays, chemistry laboratories in academic institutions use large amounts of chemicals. The ever rising cost of chemicals adversely affects many of the practical exercises. The fumes, gases and wastes produced during chemical reactions pollute the environment and affect public health. The awareness and implementation of eco-friendly experiments thus becomes a global necessity. It is in this context, that the need for greener approaches becomes more relevant. It is essential to ensure that laboratory chemicals are used at a minimal level without affecting the skill and understanding aimed through laboratory sessions. In the present scheme use of micro scale techniques and double burette titrations are promoted.

The syllabus has been prepared in a participatory manner, after discussions with a number of faculty members in the subject and uploading the draft syllabus in the university website and collecting the feedback. As far as possible, the suggested modifications from the teaching community have been incorporated into the syllabus. During the preparation of the syllabus, the existing syllabus of the University of Calicut, the syllabi of XIth & XIIth standards, UGC model curriculum and the syllabi of other universities have also been referred to. Care has been taken to ensure that the syllabus is compatible with the syllabi of other universities at the same level. Sufficient emphasis is given in the syllabus for training in laboratory skills and instrumentation.

The units of the syllabus are well defined. The number of contact hours required for each unit is also given. A list of reference books is provided at the end of each course.

AIMS

This curriculum has been prepared with the objective of giving sound knowledge and understanding of chemistry to undergraduate students. The goal of the syllabus is to make the study of chemistry stimulating, relevant and interesting. It has been prepared with a view to equip students with the potential to contribute to academic and industrial environments. This curriculum will expose students to various fields in chemistry and develop interest in related disciplines. Chemistry, being a border science to biology, physics and engineering, has a key role to play in the understanding of these disciplines. The updated syllabus is based on an interdisciplinary approach to understand the application of the subject in daily life.

BROAD OBJECTIVES

To enable the students

- To understand basic facts and concepts in chemistry.
- To develop the ability for applying the principles of chemistry.
- To appreciate the achievements in chemistry and to know the role of chemistry in nature and in society.
- To familiarize the emerging areas of chemistry and their applications in various spheres of chemical sciences and to apprise the students of its relevance in future studies.
- To develop skills in the proper handling of instruments and chemicals.
- To be exposed to the different processes used in industries and their applications.
- To make the students eco-friendly by creating a sense of environmental awareness in them.
- To make the students aware of the applications of chemistry in day-to-day life.

COURSE STRUCTURE

Semester	Common Course		Core Course Chemistry	Complimentary Course		Open Course	Total
	English	Additional Language		Maths	Physics		
I	2	1	1	1	1	-	6
II	2	1	1	1	1	-	6
III	1	1	1	1	1	-	5
IV	1	1	1+1*	1	1+1*	-	5+2*
V	-	-	3	-	-	2	5
VI	-	-	5+4*+1**	-	-	-	5+4*+ 1**
Total	6	4	12+5*+1**	4	4+1*	2	32+6*+1**

*practical **Project

DISTRIBUTION OF CREDITS

Semester	Common Course		Core Course	Complimentary Course		Open Course	Total
	English	Additional Language		Maths	Physics		
I	4+3	4	2	3	2	-	18
II	4+3	4	2	3	2	-	18
III	4	4	3	3	2	-	16
IV	4	4	3+4*	3	2+4*	-	24
V	-	-	3+3+3	-	-	2	11
VI	-	-	3+3+3+3+3 +4*+4*+4*+4* +2**	-	-	-	33
Total	22	16	56	12	12	2	120

*practical **Project

Mark Distribution and Indirect Grading System

Mark system is followed instead of direct grading for each question. After external and internal evaluations marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software. Indirect Grading System in 7 point scale is followed. Each course is evaluated by assigning marks with a letter grade (A_+, A, B, C, D, E or F) to that course by the method of indirect grading.

Mark Distribution

Sl.No	Course	Marks
1	English	600
2	Additional Laguage	400
3	Core Course: Chemistry	1750
4	Complimentary Course: Mathematics	400
5	Complimentary Course: Physics	400
6	Open Course	50
Total		3600

Seven Point Indirect Grading System

1. Grade Point (G) = $\frac{Percetage\ \ of\ Marks\ Obtained\ \ in\ a\ course}{10}$

   Grade point is expressed in a 10.0 point scale rounded off to the first decimal place and varies from 0.0 to 10.0

2. Letter Grade: Based the grade point Letter Grade is awarded as given in the following table

% of Marks (IA + ESE)	Range of Grade Point (G)	Letter Grade	Class
90 - 100	9.0 - 10.0	A^+	First Class With Distinction
80 - 89	8.0 -8.9	A	
70 - 79	7.0 -7.9	B^+	First Class
60 - 69	6.0 -6.9	B	
50 - 59	5.0 - 5.9	C	Second Class
40 - 49	4.0 - 4.9	D	Pass
Course incomplete	0.0- 3.9 = 0.0	F	Fail

3. The minimum Grade Point required for passing a course is 4.0. The grade point for marks in the range 0 to 39 is taken as 0.0.

4. Credit Point (P) = Grade Point (G) X Credit of the Course

5. Semester Grade Point Average (SGPA) =
   $\frac{Sum\ of\ credit\ points\ (P) obtained\ \ by\ the\ studentin\ \ in\ the\ various\ \ courses\ \ of\ the\ semester}{Total\ Credit\ \ of\ the\ semester}$

   If P_1, P_2 --- P_n are the Credit Points (rounded off to the first decimal place) scored by the student in various courses of the semester and C_1,C_2 --- Cn are the credits of the respective courses, then,

   Semester Grade Point Average (SGPA) = $\frac{P_1 + P_2 + \text{------} + P_n}{C_1 + C_2 + \text{------} + C_n}$

6. Cumulative Grade Point Average (CGPA) =
   $\frac{Sum\ of\ credit\ points\ (P) obtained\ \ by\ the\ studentin\ \ in\ the\ various\ \ courses\ \ of\ the\ Programme}{Total\ Credit\ \ of\ the\ Programme}$

   CGPA shall be rounded off to the first decimal place.

Example

Course Code	Course Name	Marks						Credit **C**	% Score	Grade Point **G**	grade	Credit Point **C** x **G**
		Internal		External		Total						
		Scored	Max.	Scored	Max.	Scored	Max.					
xxxxx	xxxxx	16	20	62	80	78	100	4	78	7.8	B	31.2
xxxxx	xxxxx	14	20	58	80	72	100	4	72	7.2	B	28.8
xxxxx	xxxxx	14	20	66	80	80	100	4	80	8.0	A	32.0
xxxxx	xxxxx	16	20	72	80	88	100	4	88	8.8	A	35.2
xxxxx	xxxxx	14	20	66	80	80	100	4	80	8.0	A	32.0
xxxxx	xxxxx	14	16	60	64	74	80	2	93	9.3	A	18.6
Total						**472**	**580**	**22**				**177.8**

SGPA = $\frac{Sum\ of\ credit\ points\ (P) obtained\ by\ the\ studentin\ in\ the\ various\ courses\ of\ the\ semester}{Total\ Credit\ of\ the\ semester}$

$= \frac{177.8}{22}$

= 8.1

A Grade

Note : In the event a candidate fails to secure E grade (40 % marks) in any Course in a semester, consolidation of SGPA and CGPA will be made only after obtaining E grade (40 % marks) in the failed Course in the subsequent appearance.

Credit and Mark Distribution in Each Semester

Total Credit: 120 Total Marks: 3600

Semester	No.	Course	Credit	Marks
I	1	Common Course: English	4	100
	2	Common Course: English	3	100
	3	Common Course: Additional Language	4	100
	4	Core Course I: General Chemistry	2	100
	5	Complimentary Course: Mathematics	3	100
	6	Complimentary Course: Physics	2	80
		Total	18	580
II	1	Common Course: English	4	100
	2	Common Course: English	3	100
	3	Common Course: Additional Language	4	100
	4	Core Course II: Inorganic Chemistry-I	2	100
	5	Complimentary Course: Mathematics	3	100
	6	Complimentary Course: Physics	2	80
		Total	18	580
III	1	Common Course: English	4	100
	2	Common Course: Additional Language	4	100
	3	Core Course III: Physical Chemistry - I	3	100
	4	Complimentary Course: Mathematics	3	100
	5	Complimentary Course: Physics	2	80
		Total	16	480
IV	1	Common Course: English	4	100
	2	Common Course: Additional Language	4	100
	3	Core Course IV: Organic Chemistry - I	3	100
	4	Core Course V: Volumetric Analysis (Practical – I)	4	100
	5	Complimentary Course: Mathematics	3	100
	6	Complimentary Course: Physics	2	80
	7	Complimentary Course: Physics Practical	4	80
		Total	24	660
V	1	Core Course VI: Inorganic Chemistry - II	3	100
	2	Core Course VII: Organic Chemistry - II	3	100
	3	Core Course VIII: Physical Chemistry - II	3	100
	4	Open Course	2	50
		Total	11	350
VI	1	Core Course IX: Inorganic Chemistry - III	3	100
	2	Core Course X: Organic Chemistry - III	3	100
	3	Core Course XI: Physical Chemistry - III	3	100
	4	Core Course XII: Advanced and Applied Chemistry	3	100
	5	Core Course XIII: Elective	3	100
	6	Core Course XIV: Physical Chemistry Practical (Practical II)	4	100
	7	Core Course XV: Organic Chemistry Practical (Practical III)	4	100
	8	Core Course XVI: Gravimetric Analysis (Practical IV)	4	100
	9	Core Course XVII: Inorganic Mixture Analysis (Practical V)	4	100
	10	Core Course XVIII: Project Work	2	50
		Total	33	950

Core Course Structure

Total Credit: 56 (Internal: 20% ; External: 80%)

Sem-ester	Code no of course	Course Title	Hrs/ week	Total hrs	Cre-dit	marks
I	ACHE1B01T	Core Course I: General Chemistry	2	36	2	100
	-	Core Course V: Volumetric Analysis (Practical – I)	2	36	*	
II	ACHE2B02T	Core Course II: Inorganic Chemistry-I	2	36	2	100
	-	Core Course V: Volumetric Analysis (Practical – I)	2	36	*	
III	ACHE3B03T	Core Course III: Physical Chemistry - I	3	54	3	100
	-	Core Course V: Volumetric Analysis (Practical – I)	2	36	*	
IV	ACHE4B04T	Core Course IV: Organic Chemistry - I	3	54	3	100
	ACHE4B05P	Core Course V: Volumetric Analysis (Practical – I)	2	36	4	100
V	ACHE5B06T	Core Course VI: Inorganic Chemistry - II	3	54	3	100
	ACHE5B07T	Core Course VII: Organic Chemistry - II	4	72	3	100
	ACHE5B08T	Core Course VIII: Physical Chemistry - II	4	72	3	100
	-	Core Course XIV: Physical Chemistry Practical (Practical – II)	5	90	**	
	-	Core Course XV: Organic Chemistry Practical (Practical – III)	5	90	**	
	-	Core Course XVIII: Project Work	2	36	**	
VI	ACHE6B09T	Core Course IX: Inorganic Chemistry - III	3	54	3	100
	ACHE6B10T	Core Course X: Organic Chemistry - III	3	54	3	100
	ACHE6B11T	Core Course XI: Physical Chemistry - III	3	54	3	100
	ACHE6B12T	Core Course XII: Advanced and Applied Chemistry	3	54	3	100
	ACHE6E01T	Core Course XIII: Elective*** 1.Industrial Chemistry	3	54	3	100
	ACHE6E02T	2.Polymer Chemistry				
	ACHE6E03T	3.Medicinal and environmental Chemistry				
	ACHE6B13P	Core Course XIV: Physical Chemistry Practical (Practical – II)	-		4	100
	ACHE6B14P	Core Course XV: Organic Chemistry Practical (Practical –III)	-		4	100
	ACHE6B15P	Core Course XVI: Gravimetric Analysis (Practical – IV)	5	90	4	100
	ACHE6B16P	Core Course XVII: Inorganic Mixture Analysis (Practical – V)	5	90	4	100
	ACHE6B17D	Core Course XVIII: Project Work	-		2	50
				Total	56	1750

*Examination will be held at the end of 4th semester
**Examination will be held at the end of 6th semester
***Student can select one course

SEMESTER I
Course Code: ACHE1B01T
Core Course I: GENERAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Analytical Chemistry - I (9 hrs)

Scientific methods – Observation - Formulation of hypothesis – Experiment – Theory – Law

Methods of expressing concentration: Weight percentage, molality, molarity and normality

Volumetric Analysis: Introduction - Primary and secondary standards – Standard solutions - Theory of titrations involving acids and bases, $KMnO_4$, $K_2Cr_2O_7$, I_2 and liberated I_2 - Complexometric titrations. Indicators: Theory of acid-base, redox, adsorption and complexometric indicators. Double burette method of titration: Principle and advantages.
Significant figures – Comparison of results: Standard deviation, Student 't' value .

Objectives of Chemical Research - Research design. Components of a research project: Introduction, review of literature, scope, materials and methods, results and discussion, conclusions and bibliography.

Module II: Atomic Structure (9 hrs)

Introduction based on historical development – John Dalton's atomic theory – Thomson's atom model and its limitations – Rutherford's atom model and its limitations - Failure of classical physics – Black body radiation - Planck's quantum hypothesis - Photoelectric effect - Generalization of quantum theory - Atomic spectra of hydrogen and hydrogen like atoms - Ritz-combination principle– Bohr theory of atom – Calculation of Bohr radius, velocity and energy of an electron - Explanation of atomic spectra – Rydberg equation - Limitations of Bohr theory - Sommerfeld modification - Louis de Broglie's matter waves – Wave-particle duality - Electron diffraction - Heisenberg's uncertainty principle.

Module III: Nuclear Chemistry (9 hrs)

Natural radioactivity – Modes of decay – Group displacement law – Theories of disintegration – Rate of decay – Decay constant – Half life period – Average life - Gieger-Nuttall rule – Radioactive equilibrium – Disintegration series – Transmutation reactions using protons, deutrons, α-particles and neutrons – Artificial radioactivity – Positron emission and K electron capture – Synthetic elements. Nuclear stability – N/P ratio – Packing fraction – Mass defect – Binding energy – Nuclear forces – Exchange theory and nuclear fluid theory – Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb - Nuclear reactors - Nuclear reactors in India. Isotopes: Detection – Aston's mass spectrograph – Separation of isotopes by gaseous diffusion method and thermal diffusion method – Application of radioactive isotopes – 14C dating – Rock dating – Isotopes as tracers – Study of reaction mechanism (ester hydrolysis) – Radio diagnosis and radiotherapy.

Module IV: Environmental Chemistry (9 hrs)

Air pollution: Major air pollutants - Oxides of carbon, nitrogen and sulphur - Particulates – London smog and photochemical smog. Effects of air pollution: Acid rain, green house effect and depletion of ozone. Control of air pollution - Alternate refrigerants. Bhopal Tragedy (a brief study).

Water pollution: Water pollution due to sewage and domestic wastes – Industrial effluents – Agricultural discharge – Eutrophication. Quality of drinking water - Indian standard and WHO standard. Water quality parameters: DO, BOD and COD. Toxic metals in water (Pb, Cd and Hg) - Minamata disaster (a brief study). Control of water pollution - Need for the protection of water bodies.

Soil Pollution, Thermal pollution, noise pollution and radioactive pollution (Sources, effects and consequences) - Hiroshima, Nagasaki and Chernobyl accidents (a brief study).

Pollution Control Board: Duties and responsibilities.

Text Books

- Jeffrey A. Lee, *The Scientific Endeavor: A Primer on Scientific Principles and Practice*, Pearson Education, 1999.
- J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
- M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
- B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
- H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
- S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edition, S. Chand and Sons, New Delhi, 2008 (Reprint).
- B.K. Sharma and H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996.

References

- T.F Gieryn, *Cultural Boundaries of Science*, University of Chicago Press, Chicago, 1999.
- H. Collins and T. Pinch, *The Golem: What Everyone Should Know about Science*, Cambridge University Press, Cambridge, 1993.

- D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
- C.R. Kothari, *Research Methodology: Methods and Techniques*, 2nd Revised Edition, New AgeInternational Publishers, New Delhi, 2004.
- B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.
- D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
- R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 2012.
- A.K. De., *Environmental Chemistry*, 6th Edition, New Age International (P) Ltd., New Delhi,
- A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.

SEMESTER II
Course Code: ACHE2B02T
Core Course II: INORGANIC CHEMISTRY - I
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Quantum Mechanical Treatment of Atom (12 hrs)

Operator algebra – Linear and Hermitian operators - Laplacian and Hamiltonian operators - eigen functions and Eigen values of an operator - Postulates of quantum mechanics - Well behaved functions. Time independent Schrödinger wave equation - Application to particle in a one dimensional box – Normalization of wave function - Particle in a three-dimensional box – Separation of variables - Degeneracy.

Application of Schrödinger wave equation to hydrogen atom – Conversion of Cartesian coordinates to polar coordinates - The wave equation in spherical polar coordinates (derivation not required) - Separation of wave equation - Radial and angular functions (derivation not required) – Orbitals and concept of Quantum numbers (n, l, m).

Radial functions - Radial distribution functions and their plots – Shapes of orbitals (s, p and d). Schrödinger equation for multi-electron atoms: Need for approximation methods.

Electron spin – Spin quantum number - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Module II: Periodic Table (5 hrs)

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic and ionic radii - Ionization enthalpy - Electron affinity (electron gain enthalpy) – Electronegativity. Electronegativity scales: Pauling and Mullikan scales. Effective nuclear charge – Slater rule and its applications – Polarising power. Diagonal relationship and anomalous behavior of first element in a group (basic idea only).

Module III: Chemical Bonding – I (8 hrs)

Introduction – Type of bonds – Octet rule and its limitations.

Ionic Bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds - Solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications – Properties of ionic compounds - Polarisation of ions – Fajan's rule and its applications.

Covalent Bond: Lewis theory. Valence bond theory and formation of hydrogen molecule. VSEPR theory – hybridization of atomic orbitals. Shapes of simple molecules and ions on the basis of hybridization and VSEPR theory. Examples: sp- BeCl2 , sp^2 -BF3, sp^3 -NH3, H2O, H_3O^+, SO_4^{2-}, sp^3d PCl5, sp^3d^2 SF^6,and sp^3d^3 IF7. Limitations of VBT. Properties of covalent compounds. Polarity of covalent bond – Percentage of ionic character – Dipole moment and molecular structure.

Module IV: Chemical Bonding – II (8 hrs)

Covalent Bond: Molecular Orbital Theory – LCAO - Bonding and anti bonding molecular orbitals –Bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: H_2, He_2, He_2^+ Li_2, Be_2, B_2, C_2, N_2, O_2, F_2, CO and NO. Comparison of VB and MO theories.

Metallic Bond: Free electron theory, valence bond theory and band theory (qualitative treatment only) - Explanation of metallic properties based on these theories.

Intermolecular Forces: Introduction. Hydrogen bond: Intra and inter molecular hydrogen bonds – Effect on physical properties. Induction forces and dispersion forces: Van der Waals forces, ion-dipole, dipoledipole, ion-induced dipole, dipole-induced dipole and induced dipole-induced dipole interactions.

Module V: s-block elements (3 hrs)

Hydrogen: Position in the periodic table – Isotopes of hydrogen (separation method not needed) – Difference between *ortho* and *para* hydrogen.

Alkali and Alkaline Earth Metals: Comparative study based on electronic configuration, oxidation state, size, density, melting point, boiling point, electrode potential, ionization energy, metallic character, flame colour and hydration enthalpy - Reactivity with oxygen and water – Thermal stability and solubility of sulphates and carbonates – Basicity of hydroxides - Anomalous properties of lithium and beryllium - Diagonal relationship between lithium and magnesium & beryllium and aluminium - Preparation and uses of sodium carbonate and plaster of Paris.

Text Books

- A.K. Chandra, *Introductory Quantum Chemistry*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 1994
- R.K. Prasad, *Quantum Chemistry*, 4th Edition, New Age International(P) Ltd., New Delhi, 2012.
- B.K, Sen, *Quantum Chemistry – Including Spectroscopy*, 3rd Edition, Kalyani publishers, New Delhi, 2010.
- B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
- Satya Prakash, *Advanced Inorganic Chemistry*, *Volume 1*, 5th Edition, S. Chand and Sons, New Delhi, 2012.
- Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
- R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press India Ltd., Hyderabad,2009.

References

1. D.A. McQuarrie, *Quantum Chemistry*, 2nd Edition, University Science Books, California, 2008.
2. M.C. Day and J. Selbin, *Theoretical Inorganic Chemistry*, East West Press, New Delhi, 2002.
3. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics*, 3rd Edition, Oxford University Press, New York, 1997.
4. I.N. Levine, *Quantum Chemistry*, 6th Edition, Pearson Education Inc., New Delhi, 2009.
5. Jack Simons, *An Introduction to Theoretical Chemistry*, 2nd Edition, Cambridge University Press, Cambridge, 2005.
6. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, John Wiley and Sons, New York, 200

SEMESTER III
Course Code: ACHE3B03T
Core Course III: PHYSICAL CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Gaseous State (12 hrs)

Introduction - Postulates of kinetic theory of gases - Derivation of kinetic gas equation - Maxwell's distribution of molecular velocities - Root mean square, average and most probable velocities – Collision number - Mean free path - Collision diameter - Deviation from ideal behavior - Compressibility factor –Van der Waals equation of state (derivation required) - Virial equation - Expression of Van der Waals equation in virial form and calculation of Boyle temperature - PV isotherms of real gases - Continuity of states - Isotherm of Van der Waals equation - Critical phenomena - Critical constants and their determination - Relationship between critical constants and Van der Waals constants.

Module II: Thermodynamics – I (18 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems - Intensive and extensive properties - State and path functions - Zeroth law of thermodynamics - First law of thermodynamics – Concept of heat, work, internal energy and enthalpy - Heat capacities at constant volume and at constant pressure & their relationship - Expansion of an ideal gas - Work done in isothermal expansion and reversible isothermal expansion - Calculation of W, q, ΔE and ΔH for expansion of an ideal gas under isothermal and adiabatic conditions - Joule-Thomson effect - Liquefaction of gases - Derivation of the expression for Joule Thomson coefficient – Inversion temperature.

Second law of thermodynamics - Need for the law - Different statements of the law - Carnot's cycle and its efficiency - Carnot theorem - Concept of entropy - Entropy as a state function - Entropy as a function of V & T and P & T - Entropy as a criteria of spontaneity and equilibrium.

Work and free energy functions - Criteria for reversible and irreversible processes - Gibbs-Helmholtz equation - Partial molar free energy - Concept of chemical potential - Gibbs-Duhem equation - Clapeyron
equation - Clapeyron-Clausius equation and its application.

Module III: Thermodynamics – II (9 hrs)

Thermochemistry - Standard enthalpies of solution, combustion, neutralization, dissociation, formation and reaction – Hess's law – Variation of enthalpy of reaction with temperature – The Kirchhoff equation – Bond energies.

Third law of thermodynamics - Nernst heat theorem - Statement of third law.

Fundamental concepts of Statistical Thermodynamics - Permutations and combinations – Probability - Relation between entropy and probability - Stirling's approximation - Residual entropy and absolute entropy.

Module IV: Liquid State (6 hrs)

Introduction - Uniqueness of water. Vapour pressure: Explanation and its determination. Surface tension: Explanation and its determination. Parachor: Explanation and its determination - Application to structureelucidation of compounds. Viscosity: Determination of molecular mass from viscosity measurements.
Refraction: Refractive index – Molar refraction and optical exaltation – Application to structure elucidation.

Module V: Chemical Equilibria (9 hrs)

Introduction - Law of mass action - Law of chemical equilibrium - Equilibrium constant in terms of concentration, partial pressure and mole fractions - Relationship between Kc, Kp and Kx - Thermodynamic derivation of law of chemical equilibrium - Temperature dependence of equilibrium

constant - Van't Hoff's equation - Homogeneous and heterogenous equilibria - Le Chatelier's principle and its applications to chemical and physical equilibria.

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.

2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, Sultan Chand & Sons, New Delhi, 2011.

3. J. Rajaram and J.C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.

4. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.

5. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.

References

1. Gordon M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.

2. K.L. Kapoor, *Physical Chemistry*, Volumes II and III, Macmillan Publishers, Noida, 2004.

3. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, UK, 1962.

4. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.

5. R.P. Rastogi and R.R. Misra, *An Introduction to Chemical Thermodynamics*, 6th Edition, Vikas Publishing House Pvt. Ltd., Noida, 2002.

6. T.L. Hill, *Introduction to Statistical Thermodynamics,* Addison-Wesley, New York, 1987.

7. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.

8. G.W. Castellan, *Physical Chemistry*, 3rd Edition, Addison-Wesley Educational Publishers Inc., U.S., 2004.

9. G.K. Vemula Palli, *Physical Chemistry,* Prentice Hall of India, New Delhi, 1997.

10. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.

SEMESTER IV

Course Code: ACHE4B04T
Core Course IV: ORGANIC CHEMISTRY– I
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction to Organic Chemistry (6 hrs)

Classification of organic compounds – Homologous series – Functional groups – Bonding in carbon compounds (methane, ethene and ethyne): Hybridization, bond lengths, bond angles and bond energy.
Intermolecular and intramolecular forces – types of intermolecular forces and their characteristics (Ion-dipole, Dipole-dipole, Hydrogen-bonding and London forces). Intermolecular and intramolecular hydrogen bonding. Effect of intermolecular and intramolecular forces on properties such as melting and boiling points of organic compounds.
Electron displacement in organic compounds – Definition and characteristics – Inductive effect– Electromeric effect – Mesomeric (or Resonance) effect – Hyperconjugation.

Module II: Stereochemistry (12 hrs)

Concept of isomerism: Types of isomerism–constitutional isomerism (chain, position and functional) and stereoisomerism.
Representation of Organic Molecules: Fischer, Flying wedge, Sawhorse and Newman projection.
Stereoisomerism: Classification into conformational isomerism and configurational isomerism.

Conformational Isomerism: Conformations - Conformational analysis of ethane and *n*-butane including energy diagrams. Baeyer's strain theory –Merits and demerits. Conformations of cyclohexane – Axial and equatorial bonds – Ring flipping–Conformations of mono substituted cyclohexane. *Configurational isomerism*: Optical isomerism and Geometrical isomerism.
Optical Isomerism: Optical activity – Concept of chirality – Chirality in organic molecules: Enantiomers, Diastereomers and Meso compounds. Optical isomerism in glyceraldehyde, lactic acid and tartaric acid. Relative and absolute configuration, sequence rules, D&L and R & S systems of nomenclature for acyclic optical isomers with one and two asymmetric carbon atoms. Erythro and threo representations (elementary idea only). Racemic mixture - Resolution methods - Enantiomeric excess. Optical isomerism in compounds lacking asymmetric carbon atoms: Biphenyls and allenes.
Geometrical Isomerism: Definition, condition, geometrical isomerism in but-2-ene, fumaric & maleic acid. *cis-trans* and *E-Z* notations with examples.

Module III: Reaction Mechanism: Basic Concepts (9 hrs)

The breaking and forming of bonds –Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows, homolytic and heterolytic bond breaking.
Types of reagents: Electrophiles and nucleophiles.
Types of organic reactions: Substitution, addition, elimination and rearrangement (definition and simple examples only).
Reaction Intermediates: Carbocations, carbanions, free radicals and carbenes (structure, formation and stability).
Methods of determination of reaction mechanism (Product analysis, study of intermediates, isotope effects, kinetic and stereochemical studies).

Module IV: Aliphatic Hydrocarbons (18 hrs)

Alkanes: Nomenclature – Isomerism–Classification into 1^o, 2^o and 3^o carbon atoms. Preparation– Catalytic hydrogenation of alkenes and alkynes, from alkyl halides (Reduction of alkyl halides, Wurtz reaction and Corey-House synthesis), from carbonyl compounds (Clemmensen reduction, Wolf-kishner reduction and Kolbe reaction). Chemical reactions: Halogenation–Mechanism of free radical substitution, reactivity and selectivity (chlorination versus bromination), dehydrogenation and aromatization.
Cycloalkanes: Nomenclature - Preparation by action of metallic sodium on dihaloalkane (Freund reaction) and Simmons-Smith reaction.
Alkenes: Nomenclature – Physical properties and relative stability of alkenes– Preparation: Reduction of alkynes, Dehydrohalogenation of alkyl halides (Saytzeff's rule), dehalogenation of dihaloalkanes and dehydration of alcohols (Wagner-Meerwin rearrangement). Chemical reactions: Addition of halogens (electrophilic addition with mechanism and stereochemistry), addition of hydrogen halides (Markownikov and Anti-Markownikov addition with mechanism) and addition of water (mechanism expected) – conversion to alcohol (oxymercuration-reduction and hydroboration-oxidation) – Oxidation of alkenes– Epoxidation, dihydroxylation (*Cis* and *trans* hydroxylation) and oxidative cleavage (permanganate cleavage and ozonolysis) —Allylic substitution reactions (reaction with NBS) –Polymerization of alkenes.
Alkadienes: Classification into isolated, conjugated and cumulated dienes. Chemical reactions – 1,2 and 1,4 additions of 1,3-butadiene – Diels-Alder reaction.

Alkynes: Nomenclature of alkynes– Preparation from dihalides and acetylides. Chemical reactions: Addition of hydrogen using Lindlar's catalyst and Na/liquid ammonia –Electrophilic addition of halogens and hydrogen halides–Nucleophilic addition reactions– Acidity of alkynes– Oxidation reactions (Ozonolysis and reaction with alkaline $KMnO_4$). Chemistry of the test for unsaturation: Bromine water and Baeyer's reagent.

Module V: Arenes and Aromaticity (9 hrs)

Nomenclature of benzene derivatives - Structure and stability of benzene (Kekule, Resonance and Molecular Orbital concepts). Aromaticity: the Huckel rule.

Aromatic Electrophilic substitution – General pattern of the mechanism, role of σ and π-complexes. Mechanism of nitration, halogenation, sulphonation, Friedel-Craft's alkylation and acylation. Orientation of aromatic substitution – Ring activating and deactivating groups with examples - *ortho*, *para* and *meta* directing groups. Side chain oxidation. Birch reduction.

Huckel's $(4n+2)\pi$ electron rule and its applications to aromatic – anti-aromatic – non aromatic compounds. Aromaticity of benzenoid (benzene, naphthalene and anthracene) non-benzenoid (furan, thiophene, pyrrole, pyridine) and other cyclic systems – cyclopropene and cyclopropenyl ions, cyclopentadiene and cyclopentadienyl ions, cycloheptatriene and tropylium ion, cyclooctateraene and azulene. Aromaticity and Annulenes–Aromatic heterocycles –pyrrole, pyridine, thiophene.

Text Books

1. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
2. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, PHI learning Private Ltd, New Delhi, 2005.
3. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
4. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age International Publishers, New Delhi, 2006.
5. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
6. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
7. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
8. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. E.L. Eliel, *Stereochemistry of Carbon Compounds*, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1992.
3. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
4. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York,

2008.
5. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.

SEMESTER IV

Course Code: ACHE4B05P

Core Course V: VOLUMETRIC ANALYSIS (PRACTICAL – I)

Total Hours: 144; Credits: 4; Hours/Week: 2 (I, II, III & IV Semesters)

General Instructions

1. Use safety coat, goggles, shoes and gloves in the laboratory.
2. For weighing, either electronic balance or chemical balance may be used.
3. For titrations double burette titration method may be used for acidimetry and alkalimetry.
4. A minimum number of 18 experiments should be done, covering III to VII modules, to appear for
the examination.
5. Practical examination will be conducted at the end of 4th semester.

Module I: Introduction to Laboratory Hygiene and Safety

Storage and handling of chemicals. Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases - Accidents due to acids and alkalies - Burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer - Use of calcium chloride and silica gel in desiccators. Awareness of Material Safety Data Sheet (MSDS) – R & S Phrases (elementary idea only) – Safe laboratory practices – Lab safety signs.

Module II: Introduction to Volumetric Analysis

1. Weighing using chemical balance and electronic balance.
2. Preparation of standard solutions.

Module III: Technique of Quantitative Dilution

Any five experiments of the following types.
1. Preparation of 100 mL 0.2 M H_2SO_4 from commercial acid.
2. Preparation of 250 mL 0.025 M thiosulphate from 0.1 M thiosulphate.

Module IV: Neutralization Titrations

1. Strong acid – strong base titration.
2. Strong acid – weak base titration.
3. Weak acid – strong base titration.
4. Estimation of NH_3 by indirect method.
5. Titration of HCl + CH_3COOH mixture *Vs* NaOH using two different indicators to determine the
composition.

6. Estimation of borax: Standard sodium carbonate.

Module V: Redox Titrations

a) Permanganometry

1. Estimation of oxalic acid.
2. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt.
3. Estimation of hydrogen peroxide.
4. Estimation of calcium.

b) Dichrometry

1. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator.
2. Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator.
3. Estimation of ferric iron (after reduction with stannous chloride) using internal indicator

c) Iodimetry and Iodometry

1. Estimation of iodine.
2. Estimation of copper.
3. Estimation of chromium.

Module VI: Precipitation Titration (using adsorption indicator)

1. Estimation of chloride in neutral medium.

Module VII: Complexometric Titrations

1. Estimation of zinc.
2. Estimation of magnesium.
3. Estimation of calcium.
4. Determination of hardness of water.

Module VIII: Some Estimations of Practical Importance

1. Determination of acetic acid content in vinegar by titration with NaOH.
2. Determination of alkali content in antacid tablets by titration with HCl.
3. Determination of copper content in brass by iodometric titration.
4. Determination of available chlorine in bleaching powder.
5. Determination of COD of water samples.
6. Estimation of citric acid in lemon or orange.
7. Determination of manganese content in pyrolusite.

References

1. *Guidance in a Nutshell - Compilation of Safety Data Sheets*, European Chemicals Agency, Finland, Version 1.0, December 2013
2. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
3. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
4. G.D. Christian, *Analytical Chemistry*, 7th Edition, John Wiley and Sons, New York, 2013.
5. A.L. Underwood, *Quantitative Analysis*, 6th Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 1999.
6. D.N. Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry; For I, II & III B. Sc.* Students, S.Chand & Company Ltd, New Delhi, 2012

SEMESTER V
Course Code: ACHE5B06T
Core Course VI: INORGANIC CHEMISTRY - II
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Theory of Inorganic Qualitative and Gravimetric Analysis (6 hrs)

Qualitative Analysis: Applications of solubility product and common ion effect in the precipitation of cations – Interfering acid radicals and their elimination (oxalate, fluoride, borate, phosphate, chromate, arsenite and arsenate) - Introduction of micro scale experiments in inorganic and organic qualitative analysis & their advantages. Gravimetric analysis – basic principles- precipitants, digestion, filtration, washing and incineration, Co-precipitation and post precipitation – Accuracy and precision – Classification and minimization of errors

Module II: p- block elements (16 hrs)

Boron Family: Electronic configuration, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect - Reactivity with water, hydrogen and halogen – Comparison of Lewis acidity of boron halides - Anomalous behavior of boron - Diagonal relationship between boron and silicon - Preparation, properties, structure and uses of diborane, boric acid, borazine and boron nitride – Structure of AlCl3.

Carbon Family: Electronic configuration, catenation, size, melting point, boiling point, density, standard electrode potential, ionization energy, electronegativity and oxidation state - Inert pair effect – Reactivity with water, hydrogen and halogen - Allotropy – Structure and hybridization of diamond and graphite –Fullerenes (mention only) – Amorphous carbon. Anomalous properties of carbon.

Nitrogen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state, atomicity and allotropy - Hydrides (comparison of boiling point, reducing property, basic strength and bond angle) – Structure of oxides N and P - Oxy acids of N and P (structure and

acidic strength only) –Anomalous properties of nitrogen - Preparation, properties and uses of ammonia and nitric acid.

Oxygen Family: Electronic configuration, size, ionization energy, electronegativity, oxidation state and atomicity - Hydrides (comparison of boiling point and bond angle) – Structure of SO2 and SO3 - Oxy and peroxy acids of sulphur (structure and acidic strength only) – Anomalous properties of oxygen -Preparation, properties, structure and uses of ozone, hydrogen peroxide and sulphuric acid – Role of selenium in xerography.

Halogens: Electronic configuration, size, electron affinity, standard reduction potential, bond energy, electro negativity and oxidation state - Hydrides (acidic strength, reducing property and boiling point) –Oxy acids of chlorine (structure and acidic strength only) – Structure of ClO2 – Electropositive character of iodine - Anomalous properties of fluorine - Preparation and uses of hydrochloric acid - General preparation and properties of inter halogen compounds (study of individual members not required) – Structure and hybridization of ClF3, ICl3 and IF5 - Comparison of properties of halogens and pseudo halogens (cyanogen as example) – Structure of poly halide ions.

Module III: Noble gases- (4 hrs)

Noble Gases: Discovery – Occurrence – Separation by charcoal adsorption method - Structure of oxides, fluorides and oxy fluorides of xenon - Reaction of xenon fluorides with water – Uses of noble gases.

Module IV: Inorganic Polymers (5 hrs)

Structure and applications of silicones and silicates. Phosphazenes: Preparation, properties and structure of tri phosphornitrilic chlorides. SN compounds: Preparation, properties and structure of S_2N_2, S_4N_4 and (SN)x.

Module V: Acids, bases and non- aqueous solvents (8 hrs)

Arrhenius, Bronsted- Lowry, the Lux – Flood, solvent system and Lewis concepts of acids and bases. Classification of acids and bases as hard and soft. Pearson's HSAB concept.
Non-aqueous Solvents: Classification - General properties - Self ionization and leveling effect – Reactions in liquid ammonia and liquid SO2.

Module VI: Oxidation and reduction (5 hrs)

Use of redox potential data – analysis of redox cycle, redox stability in water – Frost, Latimer and Pourbaix diagrams. Principles involved in the extraction of the elements.

Module VII: Metallurgy (12 hrs)

Occurrence of metals based on standard electrode potential – Concentration of ores – Calcination and roasting - Reduction to free metal – Electrometallurgy – Hydrometallurgy. Refining of metals: Electrolytic refining, ion exchange method, zone refining, vapour phase refining and

oxidative refining -Ellingham diagrams for metal oxides - Extractive metallurgy of Al, Fe, Ni, Cu and Ti. Alloys: Definition- Composition and uses of german silver, brass, bronze, gunmetal and alnico. Steel: Open hearth process – Classification of steel – Composition and uses of alloy steels - Intramedullary rods (a brief study).

Text Books

1. A.I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, 3rd Edition, Longmans, Green, London, 1962.

2. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.

3. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.

4. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.

5. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.

2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

3. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.

4. B. Doughlas, D.H. McDaniel and J.J. Alexander, *Concepts and Models in Inorganic Chemistry*,3rd Edition, John Wiley and Sons, New York, 1994.

5. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.

6. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, *Inorganic Chemistry*, 5th Edition, Prentice Hall, New Jersey, 2013.

7. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).

8. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-I*, 33rd Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2014.

9. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-II*, 31st Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2008.

10. A.G. Sharpe and H.J. Emeleus, *Modern Aspects of Inorganic Chemistry*, 4th Edition, UBs Publisher's Distributors Ltd., New Delhi, 2000.

SEMESTER V
Course Code: ACHE5B07T
Core Course VII: ORGANIC CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Alkyl and Aryl Halides (9h)

Nomenclature and classes of alkyl and aryl halides – preparation of alkyl halides – from alcohols and alkene, sallylic bromination of alkenes. Reactions of alkyl halides: Substitution reactions, S_N1 & S_N2 – Mechanism, Kinetics, Energy profile diagram & Stereochemistry. Factors influencing substitution reactions–nature of substrate, nucleophile, solvent, and leaving group. Relative reactivities of alkyl halides Vs allyl, vinyl and aryl halides. Elimination of alkyl halides – E1 & E2 mechanism–Saytzeff rule. Substitution Vs Elimination – Structure of haloalkane and nature of base.

Methods of formation of aryl halides, nuclear and side chain reactions. The addition-eliminationand the elimination-addition (benzyne intermediate) mechanisms of nucleophilic substitution reactions.

Module II: Organometallic Compounds – Preparation & Application (3h)

Preparation and synthetic applications of Grignard reagent, organozinc compounds and organolithium compounds

Module III: Alcohols and Phenols (12h)

Monohydric alcohols – Nomenclature, Hydrogen bonding. Methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Reaction of carbonyl compounds with Grignard reagent. Reactions of alcohols: Acidic and basic nature of alcohols, formation of ester, conversion to alkyl halides via tosylates, reaction with hydrogen halides (Lucas test), Dehydration, Oxidation (with PCC, Collin's reagent, Jone's reagent and $KMnO_4$).

Dihydric alcohols –nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

Phenols–Nomenclature, preparation of phenols (from cumene and aromatic sulphonic acid) and acidity of phenol (substituent effects). Reactions of phenols – electrophilic aromatic substitution (Bromination, Nitration and sulphonation), acylation (fries rearrangement) and carboxylation (Kolbe Schmitt reaction). Riemer-Tiemann reaction (mechanism expected), Gatterman aldehyde synthesis and Hauben-Hoesch reaction.

Module IV: Ethers and Epoxides (3 h)

Nomenclature of ethers and methods of their formation (Williamson ether synthesis). Chemical reactions: cleavage and autoxidation, Claisen rearrangement, Ziesel's method. Importance of crown ethers in organic synthesis.

Synthesis of epoxides, acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Module V: Aldehydes and Ketones (15 h)

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones–oxidation of alcohols and aromatic hydrocarbons (Etard reaction) – from acid chlorides, nitriles and carboxylic acids.

Nucleophilic addition reactions – Carbon nucleophiles (addition of HCN, wittig reaction, organometallic compounds), Oxygen nucleophiles (H_2O, alcohols, peroxyacids –Bayer-villiger oxidation), Nitrogen nucleophiles (NH_3, ammonia derivatives like 1^o amines, hydroxyl amine, hydrazine, phenylhydrazone, semicarbazide and DNP reagent) and Sulfur nucleophiles (sodium bisulfate).

Oxidation – acidified $K_2Cr_2O_7$, $KMnO_4$, CrO_3; Distinguishing aldehydes and ketones (Tollen's reagent, Fehling's solution Benedict's solution);

Reduction – Catalytic hydrogenation, Wolf-Kishner, Clemmensen, metal hydride ($LiAlH_4$ and $NaBH_4$), and MPV reduction. Reduction of ketones to pinacols.

Reactions involving α carbons of carbonyl compounds– Aldol condensation, Claisen-Schmidt reaction, Cannizzaro reaction and Benzoin condensation, Haloform reaction (mechanism expected).

Synthetic utility of the following reactions –Wittig reaction, Reformatsky reaction and Beckmann rearrangement.

Module VI: Carboxylic Acids and derivatives (18 h)

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength and reaction with bases. Preparation of carboxylic acids (hydrolysis of nitriles, oxidative cleavage of alkenes, side chain oxidation of alkyl benzenes and carboxylation of Grignard reagent).

Reactions of carboxylic acids – conversion to acid chlorides, esters, amides and acid anhydrides. Fisher esterification (mechanism expected), Reduction of carboxylic acids and decarboxylation.

Comparison of acidity of alcohols, phenols, carboxylic acids and sulphonic acids.

Dicarboxylic acids (Oxalic acid / Malonic acid / Succinic acid): Methods of formation and effect of heat and dehydrating agents.

Hydroxy acids (Lactic acid, Malic acid, Tartaric acid, and Citric acid). Structure and reactions like action of heat, oxidation and reduction with HI.

Methods of formation and chemical reactions of unsaturated monocarboxylic acids (Cinnamic acid and crotonic acid).

Derivatives of Carboxylic Acids: Synthesis, structure and nomenclature of acid chlorides, esters, amides and acid anhydrides. Relative reactivity of carboxylic acid derivatives. Interconversion of acid derivatives by nucleophilic acyl substitution (Hydrolysis, Alcoholysis, Aminolysis, Reduction, Grignard reaction). Methods of formation (Hell-Volhard-Zelinsky reaction) and chemical reactions of haloacids.

Module VII: Organic Compounds of Nitrogen (12 h)

Nitriles: Preparation of nitriles from alkyl halides, dehydration of primary amides. Reactions of nitriles: Hydrolysis into carboxylic acids, reduction to amine and Grignard addition to yield ketone.

Nitro compounds: Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitro-renes: Nucleophilic substitution reaction, Electrophilic substitution reaction and their reductions in acidic, neutral and alkaline media. Selective reduction of polynitro compounds. Ketones from nitrocompounds – Nef's reaction (mechanism not required).
Amines: Structure and nomenclature of amines. Basicity of substituted amines and aryl amines. Preparation of alkyl and aryl amines: Hofmann bromamide reaction, Gabriel-phthalimide reaction, reduction of nitro and nitrile compounds, reductive amination of aldehydic and ketonic compounds. Reactions of amines: Acylation to form amides, conversion of amine to alkene (Hofmann's elimination with mechanism and stereochemistry), Reactions of amines with nitrous acid. Distinction between primary, secondary and tertiary amine using carbylamine reaction, Hinsberg test. Synthetic transformations of aryl diazonium salts, azo coupling.

Text Books

1. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
2. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, PHI learning Private Ltd, New Delhi, 2005.
3. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition, Pearson Education, New Delhi, 2013.
4. P.S. Kalsi, *Organic Reactions, Stereochemistry and Mechanism*, 4th Edition, New Age International Publishers, New Delhi, 2006.
5. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
6. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
7. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
8. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

References

9. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
10. E.L. Eliel, *Stereochemistry of Carbon Compounds*, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1992.
11. I.L. Finar, *Organic Chemistry Vol. I*, 5th Edition, Pearson Education, New Delhi, 2013.
12. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York, 2008.
5. Jerry March, *Advanced Organic Chemistry*, 5th Edition, John Wiley and Sons, New York, 2004.

SEMESTER V
Course Code: ACHE5B08T
Core Course VIII: PHYSICAL CHEMISTRY - II
Total Hours: 72; Credits: 3; Hours/Week: 4

Module I: Kinetics & Catalysis (12 hrs)

Kinetics: Chemical kinetics and its scope - Rate of a reaction - Factors influencing the rate of a reaction -Rate law - Order and molecularity - Derivation of rate constants for first, second (with same and different
reactants), third (with same reactants only) and zero order reactions with examples (graphical representations needed) - Half life period (derivation for first and nth order reactions) - Methods to determine the order of a reaction - Steady state approximation - Parallel reactions, opposing reactions, consecutive reactions and chain reactions with examples (elementary idea only) - Effect of temperature on reaction rates - Arrhenius equation - Determination and significance of Arrhenius parameters - Theories of reaction rates - Collision theory - Derivation of rate equation for bimolecular reactions using collision theory - Transition state theory - Expression for rate constant based on equilibrium constant and thermodynamic aspects (derivation not required) - Unimolecular reactions - Lindemann mechanism.
Catalysis: Homogeneous and heterogenous catalysis - Theories of homogenous and heterogenous catalysis - Enzyme catalysis - Michaelis-Menten equation (derivation not required).

Module II: Photochemistry (6 hrs)

Introduction - Difference between thermal and photochemical processes - Beer Lambert's law. Laws of photochemistry: Grothus-Draper law and Stark-Einstein's law of photochemical equivalence. Quantum yield and its explanation – Photosynthesis - Photochemical hydrogen-chlorine and hydrogen-bromine reactions. Photophysical processes: Jablonski diagram – Fluorescence – Phosphorescence. Non-radiative processes: Internal conversion and inter system crossing. Photosensitization – Chemiluminescence.
Chemistry of vision.

Module III: Adsorption & Colloids (9 hrs)

Adsorption: Introduction - Difference between adsorption and absorption - Chemisorption and physisorption - Factors affecting adsorption. Adsorption isotherms: Freundlich and Langmuir isotherms (derivation required) - Multilayer adsorption - BET equation (derivation not needed) and its applications to surface area measurements. Applications of adsorption.

Colloids: Types and classification - Preparation and purification of colloids - Kinetic, optical and electrical properties of colloids - Protective colloids - Gold number - Hardy-Schulze rule. Emulsions and

gels: Properties and applications – Surfactants. Electrical double layer - Zeta potential – Donnan membrane equilibrium - Dorn effect – Applications of colloids.

Module IV: Phase Equilibria (9 hrs)

Introduction - Phase, component and degree of freedom - Gibbs phase rule and its derivation. One component systems: Water and sulphur systems. Two component systems: Simple eutectic system (leadsilver system) - Pattinson's process - Two component systems involving formation of compounds withcongruent melting points (zinc-magnesium system and ferric chloride-water system) - Two component systems involving formation of compounds with incongruent melting points (sodium sulphate-water system). Freezing mixtures - Thermal analysis – Cooling curve method - Deliquescence and efflorescence.

Liquid-liquid equilibria - Partially miscible and immiscible liquid systems – CST - Upper CST and lower CST - Steam distillation. Nernst distribution law: Derivation and applications.

Module V: Chromatography (9 hrs)

Introduction – Definition – Classification - Principles and applications of column chromatography, thin layer chromatography, paper chromatography, ion exchange chromatography, gel permeation chromatography, gas chromatography and high performance liquid chromatography - Rf values.

Module VI: Spectroscopy (18 hrs)

Interaction of electromagnetic radiation with matter - Energy levels in molecules - Born-Oppenheimer approximation.

Rotational Spectroscopy: Introduction - Rigid rotor - Expression for energy - Selection rules – Intensities of spectral lines - Determination of bond lengths of diatomic molecules.

Vibrational Spectroscopy: Simple harmonic oscillator – Energy levels - Force constant - Selection rules – Anharmonicity - Fundamental frequencies – Overtones – Fingerprint region - Group frequency concept - Degree of freedom for polyatomic molecules - Modes of vibrations of CO2 and H2O.

Raman Spectroscopy: Basic principles – Qualitative treatment of rotational Raman effect – Vibrational Raman spectra - Stokes & anti-stokes lines and their intensity difference - Selection rules – Mutual exclusion principle.

Electronic Spectroscopy: Basic principles - Frank-Condon principle - Electronic transitions - Singlet and triplet states - Dissociation energy of diatomic molecules – Chromophore and auxochrome - Bathochromic and hypsochromic shifts.

Nuclear Magnetic Resonance (NMR) Spectroscopy: Proton NMR and 13C NMR – Principle – Number and position of signals - Chemical shift - Intensity of signals - Different scales – Spin-spin coupling.

Electron Spin Resonance (ESR) Spectroscopy: Principle - Hyperfine structure - ESR of methyl, phenyl and cycloheptatrienyl radicals.

Module VII: Molecular Symmetry and Group Theory (9 hrs)

Elements of symmetry of molecules – Identity, proper axis of rotation, reflection plane, inversion centre and improper axis of rotation – Schonflies notation – Combinations of symmetry operations – Mathematical group – Point group classification of simple molecules – Cnv, Cnh, Dnh. Groupmultiplication table for C2v, C3v and C2h.

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.

2. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley & Sons, Canada, 1980.

3. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.

4. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, MacMillan & Company, UK, 1962.

5. J. Rajaram and J.C. Kuriacose, *Kinetics and Mechanism of Chemical Transformation*, 1st Edition, Macmillan India Ltd., New Delhi, 1993.

6. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edition, John Wiley & Sons, Inc., New York, 1989.

7. C.N. Banwell and E.M. McCash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edition, McGraw–Hill Publishing Company Limited, New Delhi, 2002.

8. Gurudeep R. Chatwal and Sham K. Anand, *Spectroscopy: Atomic and Molecular*, 5th Edition, Himalaya Publishing House, New Delhi, 2013.

9. K. Veera Reddy, *Symmetry & Spectroscopy of Molecules*, 2nd Edition, New Age International, New Delhi, 2009.

References

1. K. Laidler, *Chemical Kinetics*, 3rd Edition, Pearson Education, New Delhi, 2004.

2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing
House, New Delhi, 2012.

3. K.L. Kapoor, *Physical Chemistry Vol. 3&5*, Macmillan Publishers, Noida, 2004.

4. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997

5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.

6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.

7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.

8. N. Kundu and S.K. Jain, *Physical Chemistry*, S. Chand & Company, New Delhi, 1999.

9. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

10. B.K. Sharma, *Instrumental Methods of Chemical Analysis*, 24th Edition, Geol Publishing House, Meerut, 2005.

11. G.M. Barrow, *Introduction to Molecular Spectroscopy*, McGraw Hill, London, 1962.

12. P.R. Singh and S.K. Dixit, *Molecular Spectroscopy: Principles and Chemical Applications*, S. Chand & Company, New Delhi 1980.

13. P.K. Bhattacharya, *Group Theory and its Chemical Applications*, Himalaya Publishing House, New Delhi, 1986.

14. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd Edition, John Wiley & Sons, New York, 1990.

SEMESTER VI
Course Code: ACHE6B09T
Core Course IX: INORGANIC CHEMISTRY - IV
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Chemistry of transition and inner transition elements (12 hrs)

Transition Metals: General characteristics: Metallic character, oxidation states, size, density, melting points, boiling points, ionization energy, colour, magnetic properties, reducing properties, catalytic properties, non-stoichiometric compounds, complex formation and alloy formation. Difference between first row and other two rows. Preparation, properties, structure and uses of KMnO4 and K2Cr2O7.

Lanthanides: Electronic configuration and general characteristics – Occurrence of lanthanides - Importance of beach sands of Kerala – Isolation of lanthanides from monazite sand - Separation by ion exchange method. Lanthanide contraction: Causes and consequences. Industrial importance of lanthanides.

Actinides: Electronic configuration and general characteristics – Comparison with lanthanides.

Module II: Coordination Chemistry – I (12 hrs)

Introduction - Types of ligands – Anionic, cationic and neutral complexes – IUPAC Nomenclature - Structural and stereo isomerism in coordination compounds.

Bonding theories: Review of Werner's theory and Sidgwick's concept of coordination – EAN rule - Valence bond theory - Geometries of coordination numbers 4 and 6 – Limitations of VBT. Crystal filed theory - Splitting of *d*-orbitals in octahedral, tetrahedral, tetragonal and square planar complexes –Factors affecting crystal field splitting - CFSE of low spin and high spin octahedral complexes - Spectrochemical series - Explanation of geometry, magnetism and colour - Merits and demerits of Crystal field theory. Molecular orbital theory for octahedral complexes (with sigma bonds only).

Stability of complexes: Inert and labile complexes - Factors influencing stability. Application of complexes in qualitative and quantitative analysis.

Module III: Coordination Chemistry – II (12 hrs)

A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

Magnetic properties of transition metal complexes- Types of magnetic behaviour, methods of determining magnetic susceptibility, spin- only formula, L-S coupling, correlation of μs and μeff values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

Electronic spectra of transition metal complexes- Types of electronic transition, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel- energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Module IV: Organometallic Compounds (10 hrs)

Definition – Classification based on the nature of metal-carbon bond – Zeise's salt - Metal carbonyls –18 electron rule – Mononuclear and polynuclear carbonyls of Fe, Co and Ni (structure only) – bonding in metal carbonyls. Ferrocene: Preparation, properties and bonding (VBT only). Zeigler Natta catalyst in the polymerization of alkene and Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).

Module V: Bioinorganic Chemistry (8 hrs)

Metal ions in biological system – Trace and bulk metal ions – Haemoglobin and myoglobin (elementary idea of structure and oxygen binding mechanism) – Chlorophyll and photosynthesis(mechanism not expected) - Sodium–potassium pump – Biochemistry of Ca, Zn and Co - Toxicity of metal ions (Pb, Hg and As). Anticancer drugs: *Cis*-platin, oxaliplatin and carboplatin – Structure and significance.

Text books

1. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition,Milestone Publishers and Distributors, New Delhi, 2013.
2. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.
3. Satya Prakash, *Advanced Inorganic Chemistry*, *Volume 2*, S. Chand and Sons, New Delhi, 2005.
4. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi 2008.
5. R. Gopalan, *Inorganic Chemistry for Undergraduates*, Universities Press, Hyderabad, 2009.
6. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1st Edition, Vikas Publishing House, New Delhi, 2001.
7. Wahid U. Malik, G.D. Tuli and R.D. Madan, *Selected Topics in Inorganic Chemistry*, S. Chand and Co., New Delhi, 2010 (Reprint).

References

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry – Principles of Structure and Reactivity*, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edition, Oxford University Press, New York, 2010.
4. Gary L. Miessler, Paul J. Fischer and Donald A. Tarr, *Inorganic Chemistry*, 5th Edition, Prentice Hall, New Jersey, 2013.
5. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-I*, 33rd Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2014.
6. Gurudeep Raj, *Advanced Inorganic Chemistry Vol-II*, 31st Edition, Krishna Prakashan Media (P) Ltd., Meerut, 2008.
7. F. Basolo and R.C. Johnson, *Coordination Chemistry*, 2nd Edition, Science Reviews, Wilmington, DE, 1986.
8. P. Powell, *Principles of Organometallic Compounds*, 2nd Edition, Chapman and Hall, London, 1988.

SEMESTER VI
Course Code: ACHE6B10T
Core Course X: ORGANIC CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Structure Elucidation Using Spectral Data (9 hrs)

Application of spectral techniques in the structural elucidation of organic compounds. *UV-Visible Spectroscopy:* Introduction - Beer-Lambert's law - Electronic transitions in molecules ($\sigma \rightarrow \sigma^*$, $n \rightarrow \sigma^*$, $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$) - Chromophore and auxochrome - Red shift and blue shift. UV spectra of butadiene, acetone, methyl vinyl ketone and benzene.

IR: Concept of group frequencies - IR spectra of alcohols, phenols, amines, ethers, aldehydes, ketones, carboxylic acids, esters and amides.

^{1}H NMR: Chemical shift – Spin-spin splitting - Interpretation of ^{1}H NMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, acetone, 1, 1, 2-tribromoethane, propanoic acid, ethyl acetate, toluene and acetophenone.

Problems pertaining to the structures elucidation of simple organic compounds using UV, IR and ^{1}H NMR spectroscopic, techniques.

Module II: Carbohydrates (9 hrs)

Classification– representation of monosaccharides – Fischer projection – D, L configuration– Cyclic structure of ribose, glucose and fructose – Epimers and anomers – Mutarotation – Reactions of glucose - Killiani-Fischer synthesis and Ruff degradation – Conversion of aldoses to ketoses and vice versa – Osazone formation.

Disaccharides: Cyclic structure of maltose, lactose and sucrose – Inversion of cane sugar. *Polysaccharide* : Structure of cellulose, starch and glycogen (structure elucidation not required). Test for carbohydrates: Chemistry of Tollen's test, Fehling's test, Benedict's test and Molisch test –Applications of carbohydrates.

Module III: Amino Acids, Peptides, Proteins and Nucleic acids (12 hrs)

Amino acids – Classification – Structure of amino acids - Zwitter ion formation - Isoelectric point–Electrophoresis. Synthesis (Strecker synthesis and amino malonate synthesis) and reactions of α-amino acids.

Peptides and Proteins – Structure determination of peptides: Edmann degradation and Sanger's methods. Peptide synthesis: Solid phase synthesis. Levels of protein structure - Primary, secondary, tertiary and quaternary structure of proteins. Denaturation of proteins.

Nucleic acids: Introduction, constituents of nucleic acids – nitrogenous bases, nucleosides and nucleotides. Double helical structure of DNA – DNA replication and protein synthesis – Difference between DNA & RNA – DNA finger printing and its applications.

Module IV: Lipids, Steroids and Vitamins (6 hrs)

Lipids: Classification – Fats and oils – Hydrogenation –Analysing Fats and Oils–Acid value, Saponification value, Iodine value. Phospholipids: Structure of Lecithin. Biological functions of lipids.

Steroids: sterols – cholesterol, elementary idea of HDL and LDL, Cholesterol and heart attack. Sex hormones – structure and biological functions.

Vitamins: Classification, source and deficiency diseases of vitamins. Chemical structure of vitamin D *(Structural elucidation not expected)*.

Module V: Terpenes and Alkaloids (9 hrs)

Terpenes - Classification - Isoprene rule - Essential oils - Isolation of essential oils by steam distillation and enfleurage process. Source, structure and uses of citral, geraniol, menthol, limonene and camphor. General methods of determination of structure. Structural elucidation and synthesis of geraniol. Structure of natural rubber – Vulcanization and its advantages.

Alkaloids - Classification – Source, general methods of isolation, structure and physiological functions of nicotine, coniine and piperine. General methods of determination of structure of alkaloids.

Module VI: Pericyclic Reactions (9 hrs)

Features – Molecular orbitals of conjugated π–systems (C2, C3, C4, C5 and C6 systems). Frontier Molecular Orbitals (FMOs). Types of pericyclic reactions – *Electrocyclic reactions*: Mode of rotations, Butadiene-cyclobutene and hexatriene-cyclohexadiene interconversions. *Cycloaddition reaction* – modes of addition – Diels-Alder reaction – Analysis with FMO method – *Sigmatropic rearrangement* – [1,3] and [1,5] re-arrangements – Cope and Claisen rearrangements. Pericyclic reactions in human body – Vitamin D from Cholesterol.

Text Books

1. P.S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry***,** 6th Edition, New Age International (P) Ltd., New Delhi, 2004.
2. John McMurry, *Introduction to Organic Chemistry*, Brooks/Cole, Pacific Grove, California, 2007.
3. Bhupinder Mehta and Manju Mehta, *Organic Chemistry*, PHI learning Private Ltd, New Delhi, 2005.
4. I.L. Finar, *Organic Chemistry Vol. II*, 5th Edition, Pearson Education, New Delhi, 2013.
5. Jagdamba Singh and Jaya Singh, *Photochemistry and Pericyclic Reactions*, 3rd Edition, New Age Science Ltd., New Delhi, 2009.
6. R.T. Morrison, R.N. Boyd, *Organic Chemistry*, 7th Edition, Pearson Education, New Delhi, 2013.
7. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
8. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.
9. S.C. Sharma and M.K. Jain, *Modern Organic Chemistry*, Vishal Publishing Company, New Delhi, 2014.

References

1. J. Clayden, N. Greeves and S. Warren, *Organic Chemistry*, 2nd Edition, Oxford University Press, New York, 2012.
2. R.M. Silverstein and F.X. Webster, *Spectrometric Identification of Organic Compounds*, 6th Edition, John Wiley and Sons, New York, 2004.
3. G.M. Louden, *Organic Chemistry*, 4th Edition, Oxford University Press, New York,

2008.
4. O.P. Agarwal, *Chemistry of Organic Natural Products Vol. I*, 40th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2010.
5. O.P. Agarwal, *Chemistry of Organic Natural Products Vol. II*, 38th Edition, Krishna Prakashan Media Pvt. Ltd., Meerut, 2010.

SEMESTER VI
Course Code: ACHE6B11T
Core Course XI: PHYSICAL CHEMISTRY - III
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Electrochemistry – I (12 hrs)

Faraday's laws and applications – Conductance - Specific conductance, molar conductance and equivalent conductance - Measurement of equivalent conductance - Variation of conductance with dilution - Migration of ions and Kohlrausch's law - Arrhenius theory of electrolyte dissociation and its limitations - Weak and strong electrolytes - Ostwald's dilution law, its uses and limitations - Debye- Huckel-Onsager's equation for strong electrolytes (elementary treatment only) - Debye-Falkenhagen and Wein effects - Transport number and its determination by Hittorf's and moving boundary methods.
Applications of conductivity measurements: Determination of degree of dissociation, ionic product of water and solubility product of sparingly soluble salts - Conductometric titrations.

Module II: Electrochemistry – II (15 hrs)

Galvanic cells - Reversible cells - Reversible electrodes - Types of reversible electrodes – Reference electrodes - Standard hydrogen electrode, calomel electrode and quinhydrone electrode – Standard electrode potential - Electrochemical series - Nernst equation for electrode potential and EMF of a cell - Relationship between free energy and electrical energy - Gibbs Helmholtz equation to galvanic cells.
Concentration cells: Concentration cells with and without transference - Liquid junction potential.
Application of EMF measurements: Solubility of sparingly soluble salts - Determination of pH – pH measurement using glass electrode - Potentiometric titrations - Hydrogen-oxygen fuel cell - Electrochemical theory of corrosion of metals.

Module III: Ionic Equilibria (6 hrs)

Theories of acids and bases: Arrhenius, Lowry-Bronsted and Lewis theories – Levelling and differentiating solvents – pKa, pKb and pH - Applications of common ion effect and solubility product – Hydrolysis of salts of all types – Degree of hydrolysis - Hydrolysis constant and its relation with kw. Buffer solutions – Mechanism of buffer action - Buffer index – Henderson equation – Applications of buffers.

Module IV: Solutions (6 hrs)

Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications - Raoult's law – Ideal and non ideal solutions - Dilute solutions - Colligative properties - Qualitative treatment of colligative properties - Relative lowering of vapour pressure - Elevation of boiling point - Depression in freezing point - Osmotic pressure - Reverse osmosis and its applications - Application of colligative properties in finding molecular weights (thermodynamic derivation not needed) - Abnormal molecular mass – Van't Hoff factor.

Module V: Solid State – I (12 hrs)

Nature of solid state – Amorphous and crystalline solids - Law of constancy of interfacial angles - Law of rational indices - Space lattice and unit cell - Miller indices - Seven crystal systems and fourteen Bravais lattices - X-ray diffraction - Bragg's law (derivation required) - Simple account of rotating crystal method and powder pattern method - Analysis of powder patterns of NaCl, CsCl and KCl - Simple, face centered and body centered cubic systems - Identification of cubic crystals from inter-planar ratio - Close packing of spheres - Structure of simple ionic compounds of the type AB (NaCl and CsCl) and AB2 (CaF2).

Module VI: Solid State – II (3 hrs)

Defects in crystals. Stoichiometric defects: Schottky and Frenkel defects. Non-stoichiometric defects: Metal excess, deficiency and impurity defects. Semi conductors: Intrinsic and extrinsic conduction (elementary idea). Liquid crystals: Classification and applications (elementary idea).

Text Books

1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.

2. P.L. Soni, O.P. Dharmarha and U.N. Dash, *Textbook of Physical Chemistry*, 23rd Edition, SultanChand & Sons, New Delhi, 2011.

3. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press Pvt. Ltd., New Delhi, 2007
(Reprint).

4. Gurdeep Raj, *Advanced Physical Chemistry*, 35th Edition, Goel Publishing House, Meerut, 2009.

5. S. Glasstone and D.H. Lewis, *Elements of Physical Chemistry*, 2nd Edition, Macmillan & Company, New York, 1962.

6. C.N.R. Rao and J. Gopalakrishnan, *New Directions in Solid State Chemistry*, 2nd Edition, Cambridge University Press, Cambridge, 1997.

References

1. J. Bockris, O'M and A.K.N. Reddy, *Modern Electrochemistry*, Kluwer Academic/Plenum Publishers, New York, 2000.

2. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.

3. K.L. Kapoor, *Physical Chemistry*, Macmillan Publishers, Noida, 2004.

4. G.K. Vemula Palli, *Physical Chemistry*, Prentice Hall of India, New Delhi, 1997.

5. P.W. Atkins, *Physical Chemistry*, 8th Edition, Oxford University Press, New Delhi, 2006.

6. G.M. Barrow, *Physical Chemistry*, 5th Edition, McGraw Hill, London, 1992.

7. W.J. Moore, *Physical Chemistry*, 5th Edition, Orient Longman, London, 1999.

8. S.H. Maron and C.F. Pruton, *Principles of Physical Chemistry*, Macmillan Company, New York,1968.

9. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.

10. L.V. Azaroff, *Introduction to Solids*, Tata McGraw Hill Publishing Company, New Delhi, 1960

SEMESTER VI
Course Code: ACHE6B12T
Core Course XII: ADVANCED AND APPLIED CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Nanochemistry (6 hrs)

Historical introduction to nanochemistry - Nanosize domain - Classification of nanomaterials (0D, 1D and 2D) - Size dependence of material properties - Surface area to volume ratio and its significance - Variation in electronic and optical properties. Introduction to metal nanoparticles (gold, silver and platinum nanoparticles), semiconductor nanoparticles or quantum dots (CdS and CdSe nanoparticles) and metal oxide nanoparticles (zinc oxide, iron oxide, silica and titania nanoparticles). Carbon nanostructures: Fullerenes, carbon nanotubes and graphene (elementary idea only). Applications of nanomaterials in electronics, optics, catalysis, medicine and in environment related issues (detailed discussion not required).

Module II: New Areas in Chemistry (9 hrs)

Green Chemistry: Introduction - Environmental concern on chemical industry and need of green chemistry – Origin of green chemistry – Twelve principles of green chemistry with explanations - Atom economy and microwave assisted reactions - Green solvents - Green synthesis of

ibuprofen. Microwave and ultrasound assisted green synthesis: Aldol condensation, Diels-Alder reaction and Williamson's synthesis.

Supramolecular Chemistry: Introduction – Concepts of primary and secondary structures with examples(structures of protein and DNA) - Molecular recognition - Host-guest interactions - Types of noncovalent interactions.

Combinatorial Chemistry: Introduction – Combinatorial synthesis (elementary idea only). Applications of combinatorial synthesis in drug discovery (brief study).

Module III: Introduction to C language (6 hrs)

Fundamentals – Introduction to C language, C characters, constants and variables – C statements – conditional statement – simple C programs (1) calculation of molecular mass of organic compounds (2) Calculation of normality, molality and molarity (3) Factorial of a number (4) Determination of half life and average life of radioactive element (5) Determination of pH – Introduction to free and open chemistry softwares available in the internet for drawing structures and molecular viewing.

Module IV: Synthetic Polymers (6 hrs)

Classification - Tacticity – Monomers, structural formula and applications of addition polymers (polyethene, polystyrene, PVC, teflon, PAN, PMMA, polyacetylene, Buna S, Buna N and neoprene) and condensation polymers (nylon 66, nylon 6, bakelite, melmac, terylene, kevlar, lexan and nomex) – Advantages of Ziegler Natta polymerization (mechanism not expected) - Plastic identification codes. Biodegradable polymers: PGA, PLA and PHBV.

Module V: Applied Inorganic Chemistry (9 hrs)

Cement (manufacture, composition and setting) - Glass (manufacture, annealing, types of glasses and uses) - Refractory materials (borides and carbides) - Inorganic fertilizers - Essential nutrients for plants - Nitrogenous, phosphatic and potash fertilizers - Rocket propellants (classification with examples) - Composition and health effect of toothpaste and talcum powder.

Chemical industries in Kerala: Location, raw materials, chemistry involved in the preparation and uses of the following.
Fertilizers and Chemicals Travancore Ltd.: Ammonium sulphate.
Travancore Cochin Chemicals Ltd.: Caustic soda and chlorine.
Malabar Cements Ltd.: Cement.
Steel Complex Ltd.: Various grades of steel billets.
Travancore Titanium Products Ltd.: Titanium dioxide pigment from ilmenite.

Module VI: Applied Organic Chemistry – I (9 hrs)

Petroleum: Carbon range and uses of various fractions of petroleum distillation – Petrol - Knocking -Octane number – Anti-knocking compounds – Diesel oil - Cetane number – Flash point – Composition and uses of LPG and CNG.

Pharmaceuticals: Medicinal chemistry - Drugs (chemical, generic and trade names with examples). Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anesthetics, narcotics, tranquilizers, antidepressants and psychedelic drugs (definition and examples, structures not expected) - Preparation of paracetamol and aspirin.

Cleansing Agents: Soaps and detergents: Preparation, classification, advantages and disadvantages – TFM - Cleaning action – Composition of shaving creams. Shampoos: Ingredients and functions. Different kinds of shampoos: Anti-dandruff, anti-lice, herbal and baby shampoos. Health effects of shampoos.

Pesticides: Insecticides, herbicides, rodenticides and fungicides (definition and examples) – Structure of Endosulfan, DDT and BHC - Harmful effects of pesticides. Endosulfan disaster in Kerala (brief study).

Module VII: Applied Organic Chemistry – II (9 hrs)

Dyes: Definition - Requirements of a dye - Theories of colour and chemical constitution – Classification based on structure and mode of application to the fabric - Preparation and uses of Rosaniline and Indigo.

Cosmetics: Chemicals used in and health effects of hair dye, perfumes, antiperspirants, cleansing creams (cold creams, vanishing creams and bleach creams), sun screen preparations, UV absorbers, skin bleaching agents, depilatories, nail polishes, lipsticks and eye liners - Turmeric and Neem preparations - Vitamin oil. Harmful effects of cosmetics.

Food Chemistry: Common food adulterants in various food materials and their identification: Milk,

vegetable oils, tea, coffee powder, rice and chilly powder. Methods of preservation: Drying, pasteurization, refrigeration, vacuum packing, use of salt and pickling. Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) - Structure of BHT, BHA and Ajinomoto – Common permitted and non-permitted food colours (structures not required) – Artificial ripening of fruits and its health effects. Modern food: Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates and soft drinks. Harmful effects of modern food habits. Natural food: Composition and advantages of milk - Importance of regional and seasonal fruits – Composition, importance and medical uses of coconut water and Neera - Advantages of traditional Kerala foods.

Text Books

1. M.A. Shah and Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, Narosa Publishing House, New Delhi, 2010.

2. V.K. Ahluwaliya, *Green Chemistry*, Narosa Publishing House, New Delhi, 2011.

3. P.S. Kalsi and J.P. Kalsi, *Bioorganic, Bioinorganic and Supramolecular Chemistry*, 1st Edition,
New Age International Publishers (P) Ltd., New Delhi, 2007.

4. W. Bannwarth and B. Hinzen, *Combinatorial Chemistry - From Theory to Application*, 2nd Edition, Wiley-VCH, 2006.

5. E. Joseph Billo, *Excel for Chemists - A Comprehensive Guide*, 3rd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2011.

6. Andrew R. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edition Prentice Hall, 2001.

7. V.R. Gowarikar, *Polymer Chemistry*, New Age International (P) Ltd., New Delhi, 2010.

8. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.

9. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

10. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

11. M.S.R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edition, Three Rivers Press, New York, 2009.

12. H.S. Rathore and L.M.L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.
13. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers, New Delhi, 2010.

References

1. T. Pradeep**,** *A Textbook of Nanoscience and Nanotechnology*, McGrawhill, New Delhi, 2012.

2. V.S. Muralidharan and A. Subramania, *Nano Science and Technology*, CRC Press, London, 2008.
3. Andrew P. Dicks, *Green Organic Chemistry in Lecture and Laboratory*, CRC Press, University of Toronto, Ontario, Canada, 2011.

4. M. Kirchhoff and M. Ryan, *Greener Approaches to Undergraduate Chemistry Experiments*, American Chemical Society, Washington, DC, 2002.

5. Helena Dodziuk, *Introduction to Supramolecular Chemistry*, Springer, New York, 2002.

6. A.W. Czarnik and S.H. DeWitt, *A Practical Guide to Combinatorial Chemistry*, 1st Edition, American Chemical Society, 1997.

7. John Walkenbach, *Excel 2013 Formulas*, 1st Edition, Wiley, New York, 2013.

8. S. Wilson, *Chemistry by Computer: An Overview of the Applications of Computers in Chemistry.*Plenum Publishing, New York, 1986.

9. Fred W. Billmeyer, Jr., *Textbook of Polymer Science*, 3rd Edition, John Wiley & Sons, Singapore, 1994.

10. P.L. Soni and Mohan Katyal, *Textbook of Inorganic Chemistry*, 20th Edition, S. Chand and Sons, New Delhi, 2013.

11. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edition, S. Chand and Company Ltd., New Delhi, 1999.

12. G. Thomas, *Fundamentals of Medicinal Chemistry,* John Wiley & Sons Ltd., 2006.

13. B. Siva Sankar, *Food Processing and Preservation*, Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.

SEMESTER VI
Course Code: ACHE6E01T
Core Course XIII: Elective 1. INDUSTRIAL CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction (6 hrs)

Requirements of an industry - Location - Water - Industrial water treatment - Safety measures – Pilot plants – ISO certification – Environmental management systems.

Module II: Petrochemical Industry (12 hrs)

Introduction. Natural gas – CNG, LNG and LPG.

Coal: Classification based on carbon content - Carbonisation of coal – Composition and uses of various fractions.

Crude Oil: Constitution and distillation - Composition and uses of different distillates - Pour points, depressants, ignition point, flash point and octane number – Cracking.

Catalysts used in Petroleum Industries: Structure, selectivity and applications.

Synthetic Petrol: Manufacture by Bergius and Fischer-Tropsch processes.

Manufacture of petrochemicals: Ethylene glycol, glycerine, acetone, phenol, vinyl acetate, toluene, linear alkyl benzenes and their sulphonates. Usage and depletion of petroleum products – Need for alternative fuel – Hydrogen as the future fuel.

Module III: Pharmaceutical Industry (12 hrs)

Drugs: Definition – History of drugs – Prodrug – Drug toxicity – Thalidomide tragedy (a brief study) -
Routes of drug administration – Effective use of drugs – Over dosage – Prescription and non-prescription drugs – Drug abuse.

Some diseases and treatment: Tuberculosis and asthma (causes and treatment). Drugs used in the treatment for systemic hypertension and hypercholesterolemia. Cancer: Definition - Lung cancer (causes,symptoms and treatment).

Indian Medicinal Plants: Kizharnelli, Thumbai, Hibiscus, Brahmi, Adathodai, Nochi, Thulasi, Aloe Vera and Neem plant (major chemical constituents and medicinal uses).
Medical applications of nanomaterials. United state pharmacopoeia, Indian pharmacopoeia and British pharmacopoeia (a brief study).

Module IV: Industrial Catalysis (6 hrs)
Types of catalysts: Homo catalysis and hetero catalysis – Applications of phase transfer catalysis and nano particle catalysts – Zeigler Natta catalyst and Wilkinson catalyst (mechanism not expected). Applications of Raney nickel, platinum, palladium, ruthenium and TiO2 based catalysts.

Module V: Leather, Sugar and Alcohol Industries (9 hrs)

Leather Industry: Manufacture of leather: Preparatory stages, tanning (vegetable and chrome tanning), crusting and surface coating– Tannery effluent and byproduct problems.

Sugar Industry: Manufacture of sugar from cane sugar - Double sulphitation process - Refining and grading of sugar.

Alcohol Industry: Fermentation of molasses and starch – Manufacture of rectified spirit – Absolute alcohol (preparation by azeotropic distillation) – Denatured spirit, proof spirit and power alcohol (synthesis and applications) - Uses of ethanol.

Module VI: Textiles, Paints and Pigments (9 hrs)

Textile Industry: Production of viscose fibre from cellulose - Properties and uses of nylon and polyester fibers - Introduction to dyeing - Chromophore, auxochrome and chromogen - Primary and secondary colours - Chromatic and achromatic colours - Dyeing of nylon with acid dyes.

Paints: Primary constituents - Binders and solvents– Requirements of a good paint - Oil based aints, latex paints, luminescent paints, fire retardant paints and heat resistant paints. Varnishes: Spirit varnishes and oleo resinous varnishes – Raw materials – Enamels and lacquers (brief study).

Pigments: Definition – White lead, lithopone, ultramarine, red lead, guignet's green and chrome yellow (composition and uses).

References

1. B.K. Sharma, *Industrial chemistry*, 11th Edition, Goel publishing House, Meerut, 2000.

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3. Marshal Sittig and M. Gopala Rao, *Outlines of Chemical Technology for the 21st Century*, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, 2010.

4. C.E. Drydens and M. Gopala Rao, *Outlines of Chemical Technology*, East-West Publishers, New Delhi, 1997.

5. K.H. Davis and F.S. Berner, *Handbook of Industrial Chemistry*, *Vols. 1 and 2*, CBS, New Delhi, 2005.

6. B.K.B. Rao, *Modern Petroleum Refining Processes*, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.

7. R.A. Meyers, *Handbook of Petroleum Refining Processes*, 3rd Edition, McGraw-Hill, Noida, 2004.

8. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., London, 2003.

9. D.J. Abraham, *Burger's Medicinal Chemistry and Drug Discovery, Vol. 1-6*, Wiley-Interscience, Hoboken, NJ, 2003.

10. Sara J. Kadolph and Anna L. Langford, *Textiles*, 10th Edition, Pearson/Prentice-Hall, New Delhi, 2007.

11. A.A. Vidya, *Production of Synthetic Fibers*, Prentice-Hall of India, New-Delhi, 1988.

12. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

SEMESTER VI
Course Code: ACHE6E02T
Core Course XIII: Elective 2. POLYMER CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Introduction (6 hrs)

Polymers and macromolecules – Monomers – Homo and hetero polymers – Copolymers - Classification based on origin (natural, semi synthetic and synthetic), synthesis (addition and condensation), structure (linear, branched chain and cross linked) and intermolecular forces(elastomeres, fibres, thermoplastics and thermosetting polymers) – Tacticity.

Module II: Types of Polymerisation (9 hrs)

Chain and step growth polymerizations – Free radical, ionic and coordination polymerizations with mechanism – Zeigler-Natta polymerization (mechanism expected) and its advantages - Ring-opening &group transfer polymerizations.

Module III: Properties and Reactions of Polymers (9 hrs)

Glass Transition Temperature (Tg): Definition- Factors affecting Tg - Importance of Tg.
Molecular Weight of Polymers: Number average, weight average and viscosity average molecular weights – Poly Dispersity Index and its significance - Molecular weights and degree of polymerisation. Viscoelasticity of polymers (basic concept only) - Vulcanisation and cyclisation reactions.
Polymer Degradation: Basic idea of thermal, photo and oxidative degradations of polymers.

Module IV: **Polymerisation Techniques and Processing (12 hrs)**

Polymerisation Techniques: Bulk, solution, suspension, emulsion, melt condensation and interfacialpolycondensation polymerisations.

Polymer Processing: Calendering, rotational moulding, compression, injection moulding, blow moulding and thermoforming.

Module V: Commercial Polymers (12 hrs)

Preparation, structure, properties and uses of polyethylene (LDPE and HDPE), polypropylene, polystyrene, PVC, PVP, saran, dynel, teflon, PAN, PMMA, super glue, synthetic rubbers (BR, SBR, nitrile rubber, neoprene, butyl rubber and silicone rubber), terylene, glyptal, lexan, kevlar, nomex, polyurethanes, melmac, phenol-formaldehyde resin and urea-formaldehyde resin – Plastic identification codes – Pollution due to plastics - Recycling of plastics.
Module VI: Advances in Polymers (6 hrs)

Polymers in medical field - High temperature and fire-resistant polymers - Conducting polymers - Carbon fibers (basic idea only).

References

1. F.W. Billmeyer Jr., *Textbook of Polymer Science*, John Wiley and Sons, New Delhi, 2007.

2. V.R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.

3. B.K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.

4. M.G. Arora, M. Singh and M.S. Yadav, *Polymer Chemistry*, 2nd Revised Edition, Anmol Publications Private Ltd., New Delhi, 1989.
5. K.J. Saunders, *Organic Polymer Chemistry*, 2nd Edition, Chapman and Hall, London, 1988.

6. Malcolm P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Edition, Oxford University Press, USA, 1998.

7. Gowri Sankar Misra, *Introductory Polymer Chemistry*, New Age International, New Delhi, 1993.

SEMESTER VI
Course Code: ACHE6E03T
Core Course XIII: Elective 3. MEDICINAL AND ENVIRONMENTAL CHEMISTRY
Total Hours: 54; Credits: 3; Hours/Week: 3

Module I: Health and Biochemical Analysis (6 hrs)

Definition of health - WHO standard - Sterilization of surgical instruments - Biochemical analysis of urine and serum.
Blood: Composition, grouping and Rh factor - Blood transfusion.

Module II: Drugs (6 hrs)
Definition – History of drugs – Prodrug – Prescription and non-prescription drugs – Routes of drug administration - Drug dosage - Effective use of drugs – Over dosage - Drug toxicity – Thalidomide tragedy (a brief study) – Drug abuse.
Assay of Drugs: Chemical, biological and immunological assays - LD50 and ED50 therapeutic index.
Indian Medicinal Plants: Kizharnelli, Thumbai, Hibiscus, Adathodai, Nochi, Thulasi, Brahmi, Aloe Vera and Neem plant (Major chemical constituents and medicinal uses).

Module III: Common Diseases and Treatment (12 hrs)
Diseases - Communicable and non-communicable diseases - Causes, symptoms and drugs used for the treatment of air-borne diseases (anthrax, chickenpox, influenza, measles and

tuberculosis), water and food borne diseases (cholera, dysentery, typhoid fever and hepatitis A), bronchial asthma, kidney stone, diabetes, myocardial infarction and AIDS – Drugs used in the treatment for systemic hypertension and hypercholesterolemia.
Cancer: Definition - Lung cancer (causes, symptoms and treatment) – Avenues for the treatment of terminal cancer.
Treatment for Specific Poisons: Snake bite, arsenic and mercury compounds.

Module IV: Environmental Toxicology (6 hrs)
Introduction – Threshold Limiting Value – Source and toxicological effects of inorganic compounds (H2S, Cl2 and asbestos), organic compounds (CCl4, phenol, benzene, phenylene diamines, nitroso amines and *p*-dichlorobenzene), persistent organic pollutants (dioxins, TCDD, pesticides: Endosulphan, carbaryl and DDT), phthalates and heavy metals (As and Hg).

Module V: Control and Monitoring of Air Pollutants (12 hrs)
Air Pollution Control Measures: Gravitational settling chamber, fabric filter, wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors, Cottrell electrostatic precipitator, extraction ventilator, zoning and green belt.
Air Pollutant Monitoring: Sampling methods for particulate analysis - Filtration, sedimentation, electrostatic samplers, thermal precipitators and impingers. Sampling methods for gases and vapours – Cold trapping, absorption and adsorption. Analytical methods for the determination of CO, NOx , SOx, H2S, hydrocarbons and particulate matter.

Module VI: Water Treatment Processes (12 hrs)

Types and characteristics of industrial waste water - Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange. Primary treatment – Secondary treatment - Trickling filters, activated sludge process and sludge digestion - Tertiary treatment – USAB process and deep well injection. Sewage and sewage analysis - Total solids, settlable solids, suspended solids, dissolved oxygen, BOD (Winkler's titration method and dissolved oxygen meter) and COD - Protection of surface waters from pollution with industrial sewage. Use and conservation of water resources – Rain water harvesting - Sea water for agriculture.

References

1. G. Thomas, *Fundamentals of Medicinal Chemistry*, John Wiley & Sons Ltd., London, 2003.

2. Guyton and Hall, *Textbook of Medical Physiology*, 12th Edition, Saunders, US, 2010.

3. D.J. Abraham, *Burger's Medicinal Chemistry and Drug Discovery, Vol.1-6*, Wiley- Interscience, Hoboken, NJ, 2003.
4. B.L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi,1979.

5. S.C. Rastogi, *Biochemistry*, 2nd Edition, Tata McGraw Hill Publishing Co., New Delhi, 2007 (Reprint).

6. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

7. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edition, S. Chand and Company Ltd., New Delhi, 1999.

8. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Edition, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.

9. A.K. De., *Environmental Chemistry*, 6th Edition, New Age International (P) Ltd., New Delhi, 2006.
10. M.L. Davis, D.A. Cornwell, *Introduction to Environmental Engineering*, 3rd Edition, McGraw Hill, New Delhi, 1998.
11. S.E. Manahan, *Environmental Chemistry*, 8th Edition, CRC Press, Florida, 2004.

12. G.M. Masters, *Introduction to Environmental Engineering and Science*, 3rd Edition, Prentice-Hall Inc., New Delhi, 2007.

13. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
14. B.K. Sharma and H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut,

SEMESTER VI
Course Code: ACHE6B13P
Core Course XIV: PHYSICAL CHEMISTRY PRACTICAL (PRACTICAL - II)
Total Hours: 90; Credits: 4; Hours/Week: 5 (Semester V)

General Instructions

1. For weighing, either electronic balance or chemical balance may be used.
2. Use safety coat, goggles, shoes and gloves in the laboratory.
3. A minimum number of 10 experiments must be done, covering the nine modules, to appear for the examination.
4. The practical must be completed in the 5th semester. Practical examination will be conducted at the end of 6th semester.

Module I: Viscosity
1. Determination of viscosity of various liquids using Ostwald's viscometer.

2. Study of glycerine-water system and determination of percentage of glycerine using viscometer (plot composition against time of flow x density of the solution).

Module II: Colligative properties (Cooling curve method)

1. Determination of cryoscopic constant (Kf) of solid solvent using a solute of known molecular mass.

2. Determination of molecular mass of the solute using a solvent of known cryoscopic constant (Kf). *Solid solvents: Naphthalene, biphenyl, camphor. Solutes: Naphthalene, biphenyl, 1,4 dichlorobenzene, diphenylamine, acetanilide, benzophenone.*

Module III: Transition Temperature

1. Determination of molal transition point depression constant (Kt) of salt hydrate using solute of known molecular mass.
2. Determination of molecular mass of the solute using a solvent of known molal transition point depression constant (Kt). *Salt hydrates: Na2S2O3.5H2O, CH3COONa.3H2O. Solutes: Urea, Glucose*

Module IV: Phase Equilibria

1. Construction of phase diagram & determination of eutectic composition and eutectic temperature: *Naphthalene-biphenyl system, Naphthelene-diphenyl amine system, Biphenyl–diphenylamine system.*
2. Influence of KCl impurity on miscibility temperature of phenol–water system and determination of concentration of given KCl solution.

Module V: Refractometry

1. Determination of composition of glycerine-water mixture by refractive index method.
2. Determination of refractive indices of KCl solutions of different concentration and concentration of unknown KCl solution.

Module VI: Conductance

1. Conductometric titration of strong acid x strong base.
2. Conductometric titration of mixture of acids (strong and weak) x strong base.

Module VII: Potentiometry

1. Potentiometric titration of strong acid x strong base.
2. Potentiometric titration of weak acid x strong base.

Module VIII: pH metry

1. Preparation of alkaline buffer solutions.
2. pH metric titration of weak acid with strong base and calculation of dissociation constant.

Module IX: Kinetics *(Demonstration experiments)*

1. Determination of specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ion at room temperature.
2. Determination of overall order of saponification of ethyl acetate.

References

1. A. Findlay, *Findlay's Practical Physical Chemistry*, 9th Edition, John Wiley and Sons, New York, 1972.

2. J.B. Yadav, *Advanced Practical Physical Chemistry*, Goel Publications, Meerut, 2008.

3. D.P. Shoemaker and C.W. Garland, *Experiments in Physical Chemistry*, McGraw-Hill Book Company, New York, 1962.
4. W.G. Palmer, *Experimental Physical Chemistry*, Cambridge University Press, Cambridge, 2009.

5. R.C. Das and B. Behra, *Experiments in Physical Chemistry*, Tata McGraw Hill, New Delhi, 1983.

6. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

SEMESTER VI
Course Code: ACHE6B14P
Core Course XV: ORGANIC CHEMISTRY PRACTICAL(PRACTICAL – III)
Total Hours: 90; Credits: 4; Hours/Week: 5 (Semester V)

General Instructions

1. Micro scale analysis must be adopted for organic qualitative analysis.
2. Use safety coat, goggles, shoes and gloves in the laboratory.
3. Reactions must be carried out in tiles, wherever possible.
4. A minimum number of 7 organic analysis and 7 organic preparations shall be done to appear for the examination.
5. The practical must be completed in the 5th semester. Practical examination will be conducted atthe end of 6th semester.

Module I: Reagent Preparation
Preparation of Borshe's reagent, Schiff's reagent, Tollen's Reagent, Fehling's solution, phenolphthalein, methyl orange, N-Phenylanthranilic acid and neutral FeCl3.

Module II: Determination of Physical Constants
1. Determination of boiling point.
2. Determination of melting point (capillary method and using melting point apparatus).

Module III: Recrystallisation Techniques
Recrystallise any four organic compounds using ethyl acetate, ethanol and water. Note the crystalline shape.

Module IV: Solvent Extraction (Use ether and record the yield recovery).
1. Aniline from water.
2. Methyl benzoate from water.

Module V: Reactions of Organic Compounds

Study of the reactions of functional groups from the following list (also prepare the derivatives).

1. Phenols (phenol, α-naphthol, β-naphthol).
2. Nitro compounds (nitrobenzene, *o*-nitrotoluene).
3. Amines (aniline, N,N-dimethyl aniline).
4. Halogen compounds (chlorobenzene, benzyl chloride, *p*-dichlorobenzene).
5. Aldehydes and ketones (benzaldehyde, acetophenone).
6. Carboxylic acid (benzoic acid, cinnamic acid, phthalic acid, salicylic acid).
7. Carbohydrates (glucose, sucrose).
6. Amides (benzamide, urea).
9. Esters (ethyl benzoate, methyl salicylate).
10. Hydrocarbons (naphthalene, anthracene).

Module VI: Organic Preparations

1. Halogenation: *p*-bromoacetanilide from acetanilide, Tribromoaniline from aniline.
2. Nitration: *p*-nitroacetanilide from acetanilide
3. Oxidation: Benzoic acid from benzaldehyde, Benzoic acid from toluene.
4. Hydrolysis: Benzoic acid from ethyl benzoate, Benzoic acid from benzamide.
5. Diazo-coupling: Methyl orange from aniline, Phenylazo–β-naphthol from aniline.
6. Haloform reaction: Iodoform from acetone or ethyl methyl ketone.
7. Acylation: Acetylation of salicylic acid or aniline, Benzoylation of aniline or phenol.

Note: *Determine the yield. Calculate the theoretical yield and percentage conversion. Recrystallise the prepared compounds from appropriate solvents.*

Module VII: Chromatography

Paper chromatographic separation of mixture of two amino acids.

References

1. B.S. Furniss, A.J. Hannaford, P.W.G. Smith and A.R. Tatchell, *Vogel's Text book of Practical Organic Chemistry*, 5th Edition, Pearson Education, Noida, 2014.
2. F.G. Mann and B.C. Saunders, *Practical Organic Chemistry*, 4th Edition, Pearson Education, Noida, 2011.
3. Arthur I. Vogel, *Elementary Practical Organic Chemistry- Small Scale Preparations*, 2nd Edition, Pearson Education, Noida, 2013.

4. V.K. Ahluwalia and S. Dhingra, *Comprehensive Practical Organic Chemistry*, Universities Press, Hyderabad, 2004 (Reprint).

SEMESTER VI
Course Code: ACHE6B15P
Core Course XVI: GRAVIMETRIC ANALYSIS (PRACTCAL-IV)
Total Hours: 90; Credits: 4; Hours/Week: 5

General Instructions

1. For weighing, either electronic balance or chemical balance may be used.
2. Use safety coat, goggles, shoes and gloves in the laboratory.
3. A minimum number of 10 experiments must be done, covering the three modules, to appear for the examination.
4. The report of industrial visit must be submitted, along with the practical record, to appear for the examination.

Module I: Gravimetric Analysis – I (using silica crucible)

1. Determination of water of hydration in crystalline barium chloride.
2. Determination of water of hydration in crystalline magnesium sulphate.
3. Estimation of Ba^{2+} as BaSO4
4. Estimation of $SO4^{2-}$ as BaSO4
5. Estimation Fe^{3+} as Fe2O3
6. Estimation Ca^{2+} as CaCO3
7. Estimation Al^{3+} as Al2O3

Module II: Gravimetric Analysis – II (using sintered crucible)

1. Estimation Ni^{2+} as nickel dimethyl glyoximate.
2. Estimation Cu^{2+} as cuprous thiocyanate
3. Estimation Mg^{2+} as magnesium oxinate

Module III: Colorimetry

1. Verification of Beer-Lambert law for KMnO4 and K2Cr2O7 & determination of concentration of the given solution.
2. Estimation of iron.
3. Estimation of chromium.
4. Estimation of nickel.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Text book of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
2. D.N Bajpai, O.P. Pandey and S. Giri, *Practical Chemistry for I, II & III B. Sc. Students*, S. Chand & Company Ltd., New Delhi, 2012 (Reprint).
3. V.K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).

4. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

SEMESTER VI
Course Code: ACHE6B16P
Core Course XVII: INORGANIC MIXTURE ANALYSIS (PRACTCAL-V)
Total Hours: 90; Credits: 4; Hours/Week: 5

General Instructions

1. Semi micro or Micro scale analysis must be adopted for inorganic qualitative analysis.
2. Mixtures containing more than one interfering anions must be avoided.
3. If interfering anions are not present, cations may be given from the same group.
4. Use safety coat, goggles, shoes and gloves in the laboratory.
5. A minimum of 6 inorganic mixtures and 6 inorganic preparations must be done to appear for the examination.

Module I: Inorganic Qualitative Analysis

1. Study of the reactions of following ions.
Anions: Carbonate, sulphate, fluoride, chloride, bromide, iodide, acetate, borate, oxalate, phosphate and nitrate.
Cations: Lead, bismuth, copper, cadmium, iron, aluminium, cobalt, nickel, manganese, zinc, barium, calcium, strontium, magnesium and ammonium.
2. Systematic analysis of mixtures containing two cations and two anions from the above list.
3. *Elimination of interfering anions:* Fluoride, borate, oxalate and phosphate.

Module II: Inorganic Preparations

1. Ferric alum
2. Potash alum
3. Mohr's salt
4. Nickel(II) dimethylglyoximate
5. Potassium trisoxalatoferrate(III)
6. Potassium trioxalatochromate(III)
7. Tris(thiourea)copper(I) sulphate
8. Tetraamminecopper(II) sulphate
9. Microcosmic salt
10. Sodium nitroprusside

References

1. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.

2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edition, The National PublishingCompany, Chennai, 1974.

3. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

SEMESTER VI
Course Code: ACHE6B17D
Core Course XVIII: PROJECT WORK
Total Hours: 36; Credits: 2; Hours/Week: 2 (Semester V)

Guidelines

1. Students shall undertake the project work related to chemistry only.

2. The UG level project work is a group activity, maximum number of students being limited to five. However, each student shall prepare and submit the project report separately.

3. Head of the department must provide the service of a teacher for supervising the project work of each group. A teacher can guide more than one group, if necessary.

4. The students must complete the project in the 5th semester. However, the evaluation of the project report will be carried out at the end of 6th semester.
5. Project work can be experimental, theoretical or both.

6. No two groups in the same institution are permitted to do project work on the same problem. Also the project must not be a repetition of the work done by students of previous batches.

7. Each group must submit a copy of the project report to keep in the department.

8. The project report must be hard bound, spiral bound or paper back.

9. The project report shall be divided as, Chapter I: Introduction, Chapter II: Review of literature, Chapter III: Scope of the research problem, Chapter IV: Materials and methods, Chapter V: Results and discussion, Chapter VI: Conclusion and suggestions, if any, and Chapter VII: Bibliography.

10. Each student must present the project report before the external examiner during project evaluation.

EVALUATION SCHEME
FOR
CORE COURSES

CORE COURSE THEORY: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university

Table 1: Components of Evaluation

Sl. No.	Components	Marks
1	Attendance	5
2	Test Papers I & II	5+5
3	Assignment	2
4	Seminar/ Viva*	3
Total		20

**Viva:* CHE1B01, CHE2B02, CHE3B03, CHE4B04, CHE5B06, CHE6B10, CHE6B11, CHE6B12 and elective course; *Seminar:* CHE5B07, CHE5B08 and CHE6B09.

Table 2: Percentage of Attendance and Eligible Marks

% of Attendance	Marks
Above 90	5
85 - 89	4
80 - 84	3
76 - 79	2
75	1

Table 3: Pattern of Test Papers

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
1.5 Hrs	One word	4	4	1	4
	Short Ansrer	5	4	2	8
	Paragraph	5	3	6	18
	Essay	2	1	10	10
				Total Marks*	40

*90% and above = 5, 80 to below 90% = 4.5, 70 to below 80% = 4, 60 to below 70% = 3.5, 50 to below 60% = 3, 40 to below 50% = 2, 35 to below 40% = 1, below 35% = 0

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

Table 1: Pattern of Question Paper

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
3 Hrs	One word	10	10	1	10
	Short Ansrer	12	10	2	20
	Paragraph	8	5	6	30
	Essay	4	2	10	20
				Total Marks*	80

CORE COURSE PRACTICAL: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	Components	Marks
1	Attendance in the lab	5
2	Punctuality, Performance and Discipline	4
3	Model tests I & II	2 + 2
4	Practical Record: Required no.of experiments and neatness	4
5	Viva - Voce	3
	Total Marks	20

Table 2: Percentage of Attendance and Eligible Marks

% of Attendance	Marks
Above 90	5
85 - 89	4
80 - 84	3
76 - 79	2
75	1

Table 3: Number of Experiments and Marks for Practical Records

No. of experiments(Marks in brackets)						
Inorganic Chemistry Practical I (Volumetry)	**Physical Chemistry Practical**	**Organic Chemistry Practical**		**Inorganic Chemistry Practical II (Gravimetry and Colorimetry)**	**Inorganic Chemistry Practical III (Mixture analysis and Preparation)**	
		Analysis	**Preparation**		**Mixture**	**Preparation**
25-28(4)	17-18(4)	10(3)	7-10(1)	13-14(4)	8(3)	8-10(1)
24(3)	16(3)	9(2.5)		12(3)	7(2)	
23(2)	15(2.5)	8(2)		11(2)	6(1)	
22(1.5)	14(2)	7(1)		10(1)		
21(1)	13(1)					

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examinations along with viva-voce will be conducted at
the end of 4th and 6th semesters.

PATTERN OF QUESTION PAPERS

Table 1: Inorganic Chemistry Practical – I

Duration	Pattern	Marks	Total Marks
3 Hrs	Questions on volumetric analysis	8	80
	Procedure	8	
	Result	40	
	Calculation	8	
	Record	8	
	Viva - Voce	8	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 8 marks. 1. Correct intermediate; 2. Preparation of standard solution; 3. Standardisation of intermediate; 4. Indicator and end point of

standardization; 5. Making up of given solution; 6. Titration of made up solution; 7. Indicator and end point of estimation; 8. Any other relevant points.
2. *Marks for Result:* For calculating the error percentage both theoretical value and skilled value are considered. The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) to calculate the error percentage. Up to 1.5% error: 40 marks; between 1.51 – 2%: 30 marks; between 2.1 – 2.5%: 20 marks; between 2.51– 3%: 10 marks; greater than 3%: 4 marks.
3. *Marks for Calculation:* Eight points – 8 marks. 1. Equivalent mass of the primary standard substance;

2. Calculation of normality of primary standard; 3. Table for standardization of intermediate with standard substance and indicator at the top; 4. Calculation of normality of the link solution; 5. Table for estimation including standard substance and indicator; 6. Calculation of normality of the given solution; 7. Equivalent mass of the compound/ion in the given solution; 8. Calculation of weight in the whole of the given solution.

Table 2: Physical Chemistry Practical

Duration	Pattern	Marks	Total Marks
3 Hrs	Procedure	8	80
	Result	40	
	Graph	8	
	Duplicate/other particulars	4	
	Calculation	4	
	Record	8	
	Viva - Voce	8	

Guidelines
1. *Valuation of Procedure:* Eight points – 8 marks.
2. *Marks for Result:* The mark distribution may vary for different experiments

Table 3: Organic Chemistry Practical

Duration	Pattern	Marks	Total Marks
3 Hrs	Questions on volumetric analysis and preparation	8	80
	Procedure for organic preparation	8	
	Organic preparation	12	
	Organic Analysis	36	
	Record	8	
	Viva - Voce	8	

Guidelines

1. *Procedure for Organic Preparation:* Eight points – 8 marks. 1) Type of reaction; 2) Balanced equation of the reaction; 3) Requirements; 4) Solvent used; 5) Reaction condition; 6) Precipitating agent; 7) Recrystallisation; 8) Solvent for recrystallisation.

2. *Organic Preparation:* The students shall exhibit the crude and recrystallized samples of the prepared organic compound for inspection. Yield: 3 marks; colour: 3 marks; dryness: 3 marks; crystalline shape: 3 marks.

3. *Organic Analysis:* Aliphatic/aromatic: 2 marks, saturated/unsaturated: 2 marks, detection ofelements: 3 marks, identification test of functional group: 5 marks, chemistry of identification test: 3
marks, confirmation test of functional group: 5 marks, chemistry of confirmation test: 3 marks, suggestion of derivative: 1 mark, method of preparation of the derivative: 2 marks, preparation of derivative suggested by the examiner: 3 marks, chemistry of the derivative preparation: 3 marks, systematic procedure: 4 marks.

Table 4: Inorganic Chemistry Practical – II

Duration	**Pattern**	**Marks**	**Total in each section**	**Total Marks**
3 Hrs	**Gravimetry and clourimetry**			**80**
	Procedure for Gravimetry	4	65	
	Procedure for Colorimetry	8		
	Result	35		
	Calculation	2		
	Record	8		
	Viva - Voce	8		
	Industrial Visit			
	Report	8	15	
	Viva - Voce	7		

Guidelines

1. *Points for Evaluation of Colorimetry Procedure*: Four points – 4 marks. 1) Preparation of standard solutions; 2) Addition of appropriate reagents to develop colour; 3) Determination of absorbance using a colorimeter; 4) Plot the graph and find out the concentration of the unknown.

2. *Points for Evaluation of Gravimetry Procedure*: Eight points – 8 marks. 1) Making up of the given solution 2) Transferring a definite volume of the made up solution in to a beaker 3) Addition of appropriate reagents 4) Dilution and heating to boiling 5) Precipitation by appropriate reagent and heating to make the precipitate granular 6) Allowing to settle and filtering through quantitative filter paper or previously weighed sintered crucible till the washings are free from ions 7) Incineration in a previously weighed silica crucible or drying the sintered crucible in an air oven 8) Repeating heating, cooling and weighing to constant weight 9)

From the weight of precipitate the weight of metal in the given solution can be calculated.

3. *Marks for Gravimetry Result:* The reported value of the student is compared with theoretical value and one skilled value (closer to theoretical value) and error percentage is calculated. Up to 1.5% error: 35 marks; between 1.51 – 2%: 25 marks; between 2.1– 2.5%: 15 marks; greater than 2.51%: 4 marks.

4. Industrial Visit: Good presentation of any one Chemical Factory / Research centre visit is considered for a maximum of 8 marks. Students are expected to make individual report. So variety must be appreciated. Viva-voce shall be conducted based on the industrial visit.

Table 5: Inorganic Chemistry Practical – III

Duration	**Pattern**	**Marks**	**Total Marks**
3 Hrs	Questions on qualitative analysis	4	80
	Procedure for inorganic preparation	4	
	Identification tests for 4 given ions	16	
	Confirmatory tests for 4 given ions	16	
	Identification of groups of 2 cations	2	
	Chemistry of identification tests	8	
	Chemistry of confirmatory tests	8	
	Systematic procedure & elimination	4	
	Chemistry of elimination	2	
	Record	8	
	Viva - Voce	8	

Guidelines
1. *Identification Tests:* 4 Marks each for two anions two cations.
2. *Identification of Cation Group:* 1 Mark each.
3. *Confirmation Tests:* 4 Marks each for two anions and two cations.
4. *Chemistry of Identification Tests:* 2 Marks each for two anions and two cations.
5. *Chemistry of Confirmation Tests:* 2 Marks each for two anions and two cations.

Table 6: Evaluation of Records

No. of experiments(Marks in brackets)						
Inorganic Chemistry Practical I (Volumetry)	**Physical Chemistry Practical**	**Organic Chemistry Practical**			**Inorganic Chemistry Practical III (Mixture analysis and Preparation)**	
		Analysis	**Preparation**	**Mixture**	**Mixture**	**Preparation**
25-28(8)	17-18(8)	10(4)	10(4)	13-14(8)	8(6)	10(2)
24(7)	16(7)	9(3)	9(3)	12(7)	7(5)	9(1.5)
23(6)	15(6)	8(2)	8(2)	11(6)	6(4)	8(1)
22(5)	14(5)	7(1)	7(1)	10(5)		
21(4)	13(4)					

CORE COURSE PROJECT: EVALUATION SCHEME

Project evaluation will be conducted at the end of sixth semester.

Table 1: Internal Evaluation

Sl.No.	Criteria	Marks
1	Punctuality	2
2	Skill in doing project work	2
3	Project presentation	3
4	Viva - Voce	3
	Total	10

Table 2: External Evaluation

Sl.No.	Criteria	Marks
1	Content and relevance of the Project	10
2	Project Report	10
3	Project presentation	10
4	Viva - Voce	10
	Total	40

QUESTION PAPER PATTERN
FOR
CORE COURSES

--------- SEMESTER B. Sc. DEGREE EXAMINATION

Course Code:---------- Course name:----------

Time: 3 Hours **Maximum marks: 80**

Section A (One word)

Answer all questions. Each question carries 1 mark

Question numbers 1 - 10: Either fill in the blanks or multiple choice

Section B (Short answer)

Answer any ten questions. Each question carries 2 marks

Question numbers 11 - 22: Answerable in one or few sentences. Definitions/equations/problems with direct application of simple equations/meaning of terms etc

Section C (Paragraph)

Answer any five questions. Each question carries 6 marks

Question numbers 23 - 30: Answerable in one or two Paragraphs. Definitions with illustration/ problems /mechanisms/method of preparations etc

Section D (Essay)

Answer any two questions. Each question carries 10 marks

Question numbers 31 – 34: Essays

Model of Practical Question Papers

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

Core Course XIII: PHYSICAL CHEMISTRY PRACTICAL

Time: 3 Hours **Maximum marks: 80**

Section A

A. Write in the first ten minutes the procedure for the question marked in Section B. *(8 Marks)*

Section B

B. Conduct the experiment for the question marked below and record the data and results neatly systematically. *(56 Marks)*

1. Determine the cryoscopic constant (Kf) of the given solid solvent 1A---. Solute IB---- of molecular mass------- is given. Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two Kf values. Weight of pure solvent given is ------ g.

2. Determine the molecular mass (M) of the given solute 2B-- by Rast method. Kf of the solvent 2A----- is--------. Conduct a duplicate experiment. Draw cooling curves for the solvent and the two trials. Report two M values. Weight of pure solvent given is ------- g.

3. Determine the transition temperature constant (Kt) of crystalline 3A----. Solute 3B-- of molecular mass------ is given. Draw cooling curves for the solvent and the two trials. Report two Kt values. Weight of pure solvent is given is ------- g.

4. Determine the molecular mass (M) of the given solute 4B-- by measuring the depression in transition temperature of the solvent 4A---. Transition temperature constant (Kt) of crystalline 4A --- is------. Draw cooling curves for the solvent and two trials. Report two M values. Weight of pure solvent given is ------- g.

5. Determine the composition of the given binary mixture of 5A----- & 5B----- viscometrically using at least five mixtures of known composition.

6. Determine the miscibility temperatures of at least five mixtures of standard aqueous solutions of sodium chloride and phenol & determine the concentration of the given sodium chloride solution 6A-------- graphically.

7. Determine the composition of the given mixture 7A--- of glycerol and water by refractometric method, using five standard mixtures of the two components.

8. By potentiometric titration, standardize the given HCl solution 8A--- with the given standard KOH solution of normality ---------.

9. By conductometric titration, standardize the given HCl solution 9A---- with the given standard KOH solution of normality ---------.

Section C

Viva-Voce *(8 marks)*

Record *(8 marks)*

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

ACHE6B14P; Core Course XIV: ORGANIC CHEMISTRY PRACTICAL

Time: 3 Hours **Maximum marks: 80**

Section A

Answer the following questions in 10 minutes.

1. The formula of Prussian blue is ----------
2. When cinnamic acid is treated with bromine water the compound formed is -------
3. When naphthalene in benzene is treated with picric acid in benzene, the compound formed has the structural formula ----------.
4. When acetophenone is treated with Borsche's reagent, the compound formed is ----.

5. Conversion of aniline into tribromoaniline is a/an ---------- reaction.

6. The electrophile during nitration is ----------

7. The structural formula of the compound formed by the acetylation of salicylic acid is ----.

8. Diazotisation of sulphanilic acid followed by coupling with N,N-dimethyl aniline yield ----.

(1x8 = 8 Marks)

Section B

Answer the following question in 10 minutes

9. Write the principle and procedure for the conversion of benzamide into benzoic acid. *(8 Marks)*

Section C

10. Convert the whole of the given acetanilide in to *p*-nitroacetanilide. Exhibit the crude and crystallised samples for inspection. *(12 Marks)*

11. Analyse qualitatively and systematically the given organic compound by micro method with a view to identify the following. (a) Detect the elements present in it. (b) Find out whether the compound is aliphatic or aromatic. (c) Find out whether the compound is saturated or unsaturated. (d) Detect the elements present in it. (e) Identify and confirm the functional groups. (f) Suggest a suitable derivative. Give its method of preparation. Prepare the derivative suggested by the examiner and exhibit. (g) Write the systematic procedure of analysis including chemistry of identification tests, confirmation tests and derivative preparation. *(36 Marks)*

Section D

Viva-Voce
(8 marks)
Record *(8 marks)*

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION
(UG-CBCSS) Chemistry

ACHE6B16P; Core Course XV: INORGANIC CHEMISTRY PRACTCAL - II

Time: 3 Hours **Maximum marks: 80**

Section A

1. Write a brief outline of the method used for the colorimetric estimation of chromium in the whole of the given solution of K2Cr2O7. *(4 Marks)*

2. Write a brief outline of the method used for the gravimetric estimation of nickel in the whole of the given solution of nickel chloride. *(8 Marks)*

Section B

3. Estimate gravimetrically the mass of barium present in the whole of the given solution of barium chloride. *(37 Marks)*

Section C

Viva-Voce based on colorimetry and gravimetry *(8 marks)*
Record *(8 marks)*

Section D

Report of industrial visit *(8 marks)*
Viva-Voce based on industrial visit *(7 marks)*

SIXTH SEMESTER B. Sc. DEGREE EXAMINATION

ACHE6B16P; Core Course XVI: INORGANIC CHEMISTRY PRACTICAL - III

Time: 3 Hours **Maximum marks: 80**

Section A

1. The reddish brown precipitate in the confirmatory test for Cu2+ ion is due to the formation of -----

2. The yellow precipitate formed in the identification test for phosphate, on adding conc. HNO3 and ammonium molybdate, has the formula ---------

3. The compound responsible for the green edged flame in the ethyl borate test is ------

4. The chemical compound formed in the ash test for zinc is ----------

(4x1 = 4 Marks)

Section B

5. Write a brief outline of the method used for the preparation of ferric alum.

(4 Marks)

Section C

6. Analyse qualitatively the given mixture by micro method to identify and confirm the two cations and two anions present in it. Record the data systematically including chemistry of identification tests, confirmation tests and elimination, if any.

(56 Marks)

Section D

Viva-Voce *(8 marks)*
Record *(8 marks)*

SYLLABUS

FOR

B.Sc. Chemistry

(Complementary course)

Sem-ester	Code no of course	Course Title	Hrs/ week	Total hrs	Cre-dit	marks
I	**ACHE1C01T**	Complimentary Course I: General Chemistry	2	36	2	80
	-	Complimentary Course V: Chemistry Practical	2	36	*	
II	**ACHE2C02T**	Complimentary Course II: Physical Chemistry	2	36	2	80
	-	Complimentary Course V: Chemistry Practical	2	36	*	
III	**ACHE3C03T**	Complimentary Course III: Organic Chemistry	3	54	2	80
	-	Complimentary Course V: Chemistry Practical	2	36	*	
IV	**ACHE4C04T**	Complimentary Course IV: Physical and Applied Chemistry	3	54	2	80
	ACHE4C05P	Complimentary Course V: Chemistry Practical	2	36	4	80
Total					12	400

*Examination will be held at the end of 4th semester

SEMESTER I

Course Code: ACHE1C01T
Complementary Course I: GENERAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Some Basic Chemical Concepts (9 hrs)

Evolution of Chemistry- Ancient speculations on the nature of matter - Early form of Chemistry –Alchemy - Origin of modern chemistry.

Modern periodic law – Long form periodic table. Periodicity in properties: Atomic radii, ionic radii,ionization enthalpy, electron affinity (electron gain enthalpy) and electronegativity (Pauling scale). Atomic mass - Molecular mass - Mole concept – Molar volume - Oxidation and reduction – Oxidation number and valency - Equivalent mass. Methods of expressing concentration: Molality, molarity, normality and mole fraction.

Theory of acids and bases: Arrhenius theory, Bronsted-Lowry theory and Lewis theory.

Module II: Analytical Chemistry (6 hrs) Theory of volumetric analysis – Acid base, redox and complexometric titrations – Acid-base, redox and complexometric indicators. Double burette method of titration: Principle and advantages.

Principles in the separation of cations in qualitative analysis - Applications of common ion effect and solubility product - Microanalysis and its advantages.

Accuracy & Precision (mention only).

Module III: Atomic Structure and Chemical Bonding (9 hrs)*Atomic Structure:* Bohr atom model and its limitations - de Broglie equation - Heisenberg uncertainty principle - Schrödinger wave equation (mention only) - Atomic orbitals - Quantum numbers and their significance - Pauli's Exclusion principle - Hund's rule of maximum multiplicity - Aufbau principle – Electronic configuration of atoms.

Chemical Bonding: Introduction – Type of bonds.
Ionic bond: Factors favouring the formation of ionic bonds - Lattice energy of ionic compounds and its application.
Covalent bond: Lewis theory - Valence bond theory – Coordinate bond.
VSEPR theory: Shapes of $BeCl_2$, BF_3, $SnCl_2$, CH_4, NH_3, H_2O, NH_4^+, SO_4^{2-}, PCl_5, SF_4, ClF_3, XeF_2, SF_6, IF_5, XeF_4, IF_7 and XeF_6.
Hybridisation involving s, p and d orbitals: sp (acetylene), sp^2 (ethylene), sp^3 (CH_4), sp^3d (PCl_5), sp^3d^2 (SF_6) and sp^3d^3 (IF_7).
Molecular orbital theory: LCAO – Electronic configuration of H_2, B_2, C_2, N_2, O_2 and CO – Calculation of bond order – Explanation of bond length and bond strength. Intermolecular forces - Hydrogen bonding in H_2O - Dipole-dipole interactions.

Module IV: Nuclear Chemistry (6 hrs)
Natural radioactivity – Modes of decay – Group displacement law. Nuclear forces - n/p ratio - Nuclear stability - Mass Defect - Binding energy. Isotopes, isobars and isotones with examples Nuclear fission - Atom bomb – Nuclear fusion – Hydrogen bomb - Nuclear reactors - Nuclear reactors in India.
Application of radioactive isotopes – ^{14}C dating – Rock dating – Isotopes as tracers – Radio diagnosis and radio therapy.

Module V: Bioinorganic Chemistry (6 hrs)
Metal ions in biological systems - Biochemistry of iron – Haemoglobin and myoglobin - Mechanism of O_2 and CO_2 transportation - Chlorophyll and photosynthesis (mechanism not expected) – Elementary idea of structure and mechanism of action of sodium potassium pump - Biochemistry of zinc and cobalt.

References

1. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2013.
2. C.N.R. Rao, *Understanding Chemistry*, Universities Press India Ltd., Hyderabad, 1999.
3. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.
4. Manas Chanda, *Atomic Structure and Chemical Bonding*, 4th Edition, Tata McGraw Hill Publishing Company, Noida, 2007.
5. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition, New Age International (P) Ltd., New Delhi, 1995 (Reprint 2005).
6. J.D. Lee, *Concise Inorganic Chemistry*, 5th Edition, Oxford University Press, New Delhi, 2008.

7.R. Gopalan, *Inorganic Chemistryfor Under graduates*, University Press, 2009.

SEMESTER II
Course Code: ACHE2C02T
Complementary Course II: PHYSICAL CHEMISTRY
Total Hours: 36; Credits: 2; Hours/Week: 2

Module I: Thermodynamics (9 hrs)

Definition of thermodynamic terms - System – Surroundings - Types of systems.First law of Thermodynamics - Internal energy - Significance of internal energy change – Enthalpy Second law of Thermodynamics - Entropy and spontaneity - Statement of second law based on entropy. Entropy change in phase transitions (derivation not required) - Entropy of fusion, vaporization and sublimation. The concept of Gibbs free energy - Physical significance of free energy - Conditions for equilibrium and spontaneity based on ΔG values - Effect of temperature on spontaneity of reaction Third law of Thermodynamics.

Module II: Gaseous and Solid States (9 hrs)

Gaseous State: Introduction - Kinetic molecular model of gases – Maxwell distribution of velocities and its use in calculating molecular velocities – Average velocity, RMS velocity and most probable velocity (derivations not required) – Boyle's law – Charles's law – Ideal gas equation – Behaviour of real gases – Deviation from ideal behavior - Van der Waals equation (derivation not required). *Solid State:* Introduction - Isotropy and anisotropy - Symmetry elements in crystals - The seven crystal systems – Miller indices - Bravais lattices – Bragg's equation (derivation required) and its applications (mention only). Defects in crystals: Non-stoichiometric and stoichiometric defects - Extrinsic and intrinsic defects. Semiconductors- n and p types.
Liquid crystals: Types, examples and applications.

Module III: Liquid State and Solutions (6 hrs)

Liquid State: Introduction - Vapour pressure, surface tension and viscosity – Explanation of these properties on the basis of intermolecular attraction.
Solutions: Kinds of solutions - Solubility of gases in liquids – Henry's law and its applications
Colligative properties - Osmotic pressure - Laws of osmotic pressure - Reverse osmosis and its applications - Determination of molecular mass using colligative properties.

Module IV: Electrochemistry (12 hrs)

Specific conductance, equivalent conductance and molar conductance - Variation of conductance with dilution - Kohlrausch's law - Degree of ionization of weak electrolytes - Application of conductance measurements – Conductometric titrations.
Ostwald's dilution law – Hydrolysis of salts - Buffer solutions – Henderson's equation – Applications of buffers.
Galvanic cells - Cell and electrode potentials - IUPAC sign convention – Reference electrodes – Standard hydrogen electrode and calomel electrode – Standard electrode potential - Nernst equation - Cation and anion reversible electrodes – H_2-O_2 fuel cell.

References

1. B.R. Puri, L.R. Sharma, *Elements of physical chemistry* 4th Edition, Vishal Publishing Company, New Delhi, 2013.
2. J. Rajaram and J.C. Kuriacose, *Chemical Thermodynamics*, Pearson Education, New Delhi, 2013.
3. K.K. Sharma and L.K. Sharma, *A Textbook of Physical Chemistry*, 5th Edition, Vikas Publishing House, New Delhi, 2012.
4. Gordon M. Barrow, *Physical Chemistry*, 5th Edition, Tata McGraw Hill Education, New Delhi, 2006.
5. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.

SEMESTER III
Course Code: ACHE3C03T
Complementary Course III: ORGANIC CHEMISTRY
Total Hours: 54; Credits: 2; Hours/Week: 3

Module I: Organic Chemistry – Some Basic Concepts (9 hrs)

Introduction: Origin of organic chemistry – Uniqueness of carbon – Homologous series – Nomenclature of alkyl halides, alcohols, aldehydes, ketones, carboxylic acids and amines. Structural isomerism: Chain isomerism, position isomerism, functional isomerism and metamerism. Hybridisation in organic molecules (a brief study) - Curved arrow formalism - Homolysis and heterolysis of bonds – Electrophiles and nucleophiles.

Electron Displacement Effects: Inductive effect: Definition - Characteristics - +I and -I groups. Applications: Explanation of substituent effect on the acidity of aliphatic carboxylic acids. Mesomeric effect: Definition – Characteristics - +M and -M groups. Applications: Comparison of electron density in benzene, nitrobenzene and aniline. Hyperconjugation: Definition – Characteristics. Example: Propene.
Applications: Comparison of stability of 1-butene & 2-butene. Electromeric effect: Definition - Characteristics - +E effect (addition of H^+ to ethene) and -E effect (addition of CN^- to acetaldehyde).
Steric effect (causes and simple examples).

Reaction Intermediates: Carbocations, carbanions and free radicals (types, hybridization and stability).

Module II: Stereochemistry (6 hrs)

Stereoisomerism; Classification into conformational isomerism and configurational isomerism.
Conformations: Conformations of ethane, cyclohexane and methylcyclohexane - Explanation of stability.
Geometrical Isomerism: Definition – Condition – Geometrical isomerism in but-2-ene and but-2-ene-1,4- dioic acid - Methods of distinguishing geometrical isomers using melting point and dipole moment.
Optical Isomerism: Optical activity – Chirality – Enantiomers - Meso compounds - Diastereoisomers – Optical isomerism in lactic acid and tartaric acid - Racemisation and resolution (elementary idea).

Module III: Aromatic Hydrocarbons (6 hrs)

Nomenclature and isomerism in substituted benzene. Structure and stability of benzene: Kekule, resonance and molecular orbital description.

Mechanism of aromatic electrophilic substitution: Halogenation, nitration, sulphonation and Friedel-Craft's reactions - Orientation effect of substituents.
Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and nonbenzenoid (pyrrole, pyridine, indol and tropylium cation) aromatic compounds.

Module IV: Chemistry of Functional Groups – I (9 hrs)

Halogen Compounds: Preparation of alkyl halides from alkanes and alkenes - Wurtz reaction and Fittig's reaction - Mechanism of SN_1 and SN_2 reactions of alkyl halides – Effect of substrate and stereochemistry.
Alcohols: Preparation from Grignard reagent/ Reduction of aldehydes and ketones - Preparation of ethanol from molasses - Wash, rectified spirit, absolute alcohol, denatured spirit, proof spirit and power alcohol (mention only) –Chemistry of methanol poisoning – Harmful effects of ethanol in the human body.
Phenols: Preparation from chlorobenzene – Comparison of acidity of phenol, *p*-nitrophenol and *p*-methoxyphenol – Preparation and uses of phenolphthalein.

Ethers: Preparation by Williamson's synthesis – Acidic cleavage - Crown ethers (mention only).

Module V: Chemistry of Functional Groups – II (9 hrs)

Aldehydes & Ketones: Preparation from alcohols – Nucleophilic addition reactions (HCN and bisulphite) - Comparison of nucleophilic addition rate of aliphatic aldehydes and ketones – Preparation and importance of urotropine.
Carboxylic Acids: Preparation from Grignard reagent - HVZ reaction – Decarboxylation - Kolbe electrolysis.

Nitro Compounds: Preparation of TNT – Reason for its explosive nature - Preparation of picric acid from phenol.
Amines: Preparation from nitro compounds - Hofmann's bromamide reaction – Hofmann's carbylamine reaction. Basicity: Comparison of basicity of (i) ammonia, methyl amine and aniline (ii) aniline, N-methyl aniline and N,N-dimethyl aniline (iii) aniline, *p*-nitroaniline and *p*-anisidine.
Diazonium Salts: Preparation and synthetic applications of benzene diazonium chloride – Preparation and uses of methyl orange.

Module VI: Biomolecules (12 hrs)

Carbohydrates: Classification with examples – Cyclic structures of glucose, fructose and sucrose –Muta rotation – Starch, cellulose and glycogen – Applications of carbohydrates.
Proteins: Amino acids – Classification – Zwitter ion formation - Peptide linkage - Polypeptides and proteins – Primary, secondary and tertiary structure of proteins - Globular and fibrous proteins – Denaturation of proteins. Enzymes: Characteristics and examples, Michaelis-Menten theory.
Lipids: Classification – Fats, oils and waxes (definition, structure and examples) – Saponification number and iodine number – Hydrogenation of oils and its application.

Nucleic acids: Structure of pentose sugar, nitrogenous base, nucleoside and nucleotide – Double-helical structure of DNA - Difference between DNA and RNA – DNA finger printing and its applications.

Moldule VII: Alkaloids and Terpenes (3 hrs)

Alkaloids: Classification – Source, structure and physiological functions of nicotine, coniine and piperine.

Terpenes: Classification with examples – Isoprene rule – Isolation of essential oils by steam distillation – Uses of lemon grass oil, eucalyptus oil and sandalwood oil - Source, structure and uses of citral,geraniol and menthol - Natural rubber - Vulcanization and its advantages.
Note: Structural elucidation not expected in any case.

References
1. P.Y. Bruice, *Essential Organic Chemistry*, 1st Edition, Pearson Education, New Delhi, 2013.
2. I.L. Finar, *Organic Chemistry Vol. I&II*, 5th Edition, Pearson Education, New Delhi, 2013.
3. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (P) Ltd., New Delhi, 2004.
4. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, 1st Multicolour Edition, S. Chand & Company, New Delhi, 2010.
5. C.N. Pillai, *Organic Chemistry for Undergraduates*, 1st Edition, University Press, Hyderabad, 2008.
6. M.S. Singh, *Advanced Organic Chemistry: Reactions and Mechanisms*, Pearson Education, New Delhi, 2014.

7.Mc Murry *Organic Chemistry:* 6th Edition, Baba Barkha nath Printers, 2009.

SEMESTER IV
Course Code: ACHE4C04T
Complementary Course IV: PHYSICAL AND APPLIED CHEMISTRY
Total Hours: 54; Credits: 2; Hours/Week: 3

Module I: Colloidal Chemistry (6 hrs)

True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - Gold number. Emulsions. Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.

Module II: Kinetics & Catalysis (9 hrs)

Kinetics: Rates of reactions - Factors influencing rate of reactions - Order and molecularity - Zero, first, second and third order reactions - Derivation of integrated rate equations for first order and second order reactions (single reactant only) - Half life period for first order reaction - Units of rate constants - Influence of temperature on reaction rates - Arrhenius equation - Calculation of Arrhenius parameters - Collision theory of reaction rate.

Catalysis: Types of catalysis – Homogeneous and heterogeneous catalysis. Theories of catalysis: Outline of intermediate compound formation theory and adsorption theory.

Module III: Chromatography (6 hrs)

Introduction - Adsorption and partition chromatography - Principle and applications of column, thin layer, paper and gas chromatography - Rf value – Relative merits of different techniques.

Module IV: Spectroscopy (9 hrs)

Origin of spectra - Interaction of electromagnetic radiation with matter. Different types of energy

levels in molecules: Rotational, vibrational and electronic levels. Statement of Born-Oppenheimer approximation - Fundamental laws of spectroscopy and selection rules (derivations not required).

IR Spectroscopy: Introduction - Group frequency concept - Characteristic stretching frequencies of O-H, N-H, C-H, C=C, C=N and C=O functional groups - Fingerprint region in IR spectra.

UV-Visible Spectroscopy: Introduction - Beer-Lambert's law - Electronic transitions in molecules

($\sigma \rightarrow \sigma^*$, $n \rightarrow \sigma^*$, $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$) - Chromophore and auxochrome - Red shift and blue shift.

NMR Spectroscopy: Introduction - Chemical shift and spin-spin coupling - Application in elucidating the structure of ethanol, dimethyl ether, propanal and acetone (detailed study not required).

Module V: Polymers (6 hrs)

Classification of polymers - Addition and condensation polymers – Thermoplastics and thermosetting plastics - Structure and applications of synthetic rubbers (Buna-S, Buna-N and neoprene), synthetic fibres (Nylon 66, Nylon 6 and dacron), thermoplastics (polyethene, polystyrene, PVC and teflon) and thermosetting plastics (bakelite and melmac). Uses of kevlar, nomex and lexan - Biodegradable polymers (PGA, PLA and PHBV) and their applications.

Module VI: Environmental Pollution (6 hrs)

Definition – Types of pollution.

Air pollution: Pollution by oxides of nitrogen, carbon and sulphur. Effects of air pollution: Depletion of ozone, green house effect and acid rain.

Water pollution: Pollution due to sewage, industrial effluents, soaps, detergents, pesticides, fertilizers and heavy metals – Eutrophication - Biological magnification and bioaccumulation - Effects of water pollution. Water quality parameters – DO, BOD and COD (elementary idea only).

Soil pollution – Pollution due to plastics.

Thermal pollution-Coal fired, steams fired steams power plants and radioactive pollution-Nuclear power plants and testings of nuclear weapons. Sources and effects

Solid Waste Management: Sanitary landfill and composting.

Module VII: Chemistry in Daily Life (12 hrs)

Petrochemicals: Name, carbon range and uses of fractions of petroleum distillation – Octane number – Cetane number – Flash point. LPG and CNG: Composition and uses.

Pharmaceuticals: Drug - Chemical name, generic name and trade names with examples. Prodrug. Antipyretics, analgesics, antibiotics, antacids, antiseptics, antihistamines and tranquilizers (definition and examples, structures not expected).

Dyes: Definition – Requirements of a dye - Theories of colour and chemical constitution - Structure and applications of Martius yellow, indigo and alizarin.

Cleansing Agents: Soaps - Saponification of lipids – Hard and soft soaps. Detergents (classification and examples) – Cleansing action - Advantages and disadvantages of soaps and detergents. Composition and health effects of tooth paste.

Cosmetics: Hair dye, Talcum powder, perfumes and deodorants (composition and health effects).

Food: Food additives: Food preservatives, artificial sweeteners and antioxidants (definition and examples, structures not required) – Structure of BHT, BHA and Ajinomoto - Commonly used permitted and non-permitted food colours (structures not required) - Fast foods and junk foods & their health effects - Artificial ripening of fruits and its health effects

Agriculture: Inorganic fertilizers: Essential nutrients for plants – Nitrogenous, phosphatic and potash fertilizers (examples only). Pesticides: Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Structure of Endosulphan, DDT and BHC - Harmful effects of pesticides.

Cement: Manufacture, composition and setting.

Glass: Manufacture – Annealing - Types of glasses and uses.

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1. B.R. Puri, L.R. Sharma and M.S. Pathania, *Principles of Physical Chemistry*, 46th Edition, Vishal Publishing Company, New Delhi, 2013.

2. F. Daniels and R.A. Alberty, *Physical Chemistry*, 5th Edition, John Wiley and Sons, Canada, 1980.
3. P.S. Kalsi, *Applications of Spectroscopic Techniques in Organic Chemistry***,** 6th Edition New Age International (P) Ltd., New Delhi, 2004.
4. C.N. Banwell and E.M. McCash, *Fundamentals* of *Molecular Spectroscopy*, 4th Edition, McGraw–Hill publishing Company Limited, New Delhi, 2002.
5. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
6. A.I. Vogel, *A Textbook of Quantitative Inorganic Analysis*, 3rd Edition, Longmans, Green, London, 1962.
7. A.K. De, *Environmental Chemistry*, 6th Edition, New Age International Pvt. Ltd., New Delhi, 2006.
8. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
9. V.R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.
10. B.R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, 31st Edition, Milestone Publishers and Distributors, New Delhi, 2009.
11. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.
12. Jayashree Ghosh, *A Textbook of Pharmaceutical Chemistry*, 3rd Edition, S. Chand and Company Ltd., New Delhi, 1999.
13. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers Pvt. Ltd., New Delhi, 2010.

SEMESTER IV
Course Code: ACHE4C05P
Complementary Course V: CHEMISTRY PRACTICAL
Total Hours: 144 Credits: 4 Hours/Week: 2 (I, II, III & IV Semesters)

General Instructions

1. Semi micro analysis or micro analysis may be adopted for inorganic qualitative analysis.
2. For weighing, either electronic balance or chemical balance may be used.
4. Standard solution must be prepared by the student.
5. Use safety coat, gloves, shoes and goggles in the laboratory.
6. A minimum of 7 inorganic mixtures and 10 volumetric estimations must be done to appear for the examination.
7. Practical examination will be conducted at the end of 4th semester.

Module I: Laboratory Safety, First Aid and Treatment of Fires

Importance of lab safety – Burns – Eye accidents – Cuts – Gas poisoning – Electric shocks – Treatment of fires – Precautions and preventive measures.

Module II: Volumetric Analysis

1. Weighing using chemical balance and electronic balance.
2. Preparation of standard solutions.

3. Neutralization Titrations
(i) Strong acid – strong base.
(ii) Strong acid – weak base.
(iii) Weak acid – strong base.

4. Redox Ttrations
Permanganometry:
(i) Estimation of oxalic acid.
(ii) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt.

Dichrometry:
(i) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using internal indicator.
(ii) Estimation of Fe2+/FeSO4.7H2O/Mohr's salt using external indicator.

Iodimetry and Iodometry:
(i) Estimation of iodine.
(ii) Estimation of copper.
(iii) Estimation of chromium.

5. ***Complexometric Titrations***
(i) Estimation of zinc.
(ii) Estimation of magnesium.
(iii)Determination of hardness of water.

Module III: Gravimetric Analysis
1. Determination of water of hydration in crystalline barium chloride.
2. Estimation of Ba2+ as BaSO4.

Module IV: Inorganic Qualitative Analysis
(a) *Reactions of Cations:* Study of the reactions of the following cations with a view of their identification and confirmation.
Pb^{2+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Ni^{2+}, Co^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+} and $NH4^{+}$.
(b) Systematic qualitative analysis of a solution containing any two cations from the above list.

Module V: Determination of Physical Constants
1. Determination of boiling point.
2. Determination of melting point.

Module VI: Organic Preparations
1. *p*-Bromoacetanilide from acetanilide.
2. *p*-Nitroacetanilide from acetanilide.
3. Benzoic acid from benzaldehyde.
4. Benzoic acid from benzamide.

References

1. J. Mendham. R.C. Denney, J.D. Barnes and M. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edition, Pearson Education, Noida, 2013.

2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8thEdition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.

3. V.K. Ahluwalia, Sunita Dhingra and Adarsh Gulati, *College Practical Chemistry*, Universities Press (India) Pvt. Ltd., Hyderabad, 2008 (Reprint).

4. G. Svehla, *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, New Delhi, 1996.

5. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd Edition, The National Publishing Company, Chennai, 1974.

6. W.G. Palmer, *Experimental Inorganic Chemistry*, Cambridge University Press, 1970.

EVALUATION SCHEME
FOR
COMPLEMENTARY COURSE

COMPLEMENTARY COURSE THEORY: EVALUATION SCHEME

The evaluation scheme for each course contains two parts: *viz.*, internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks in each course are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	Components	Marks
1	Attendance	4
3	Tests Papers I & II	4 + 4

4	Assignment	2
5	Viva - Voce	2
Total Marks		16

Table 2: Percentage of Attendance and Eligible Marks

% of Attendance	Marks
Above 90	4
85 - 89	3.2
80 - 84	2.4
76 - 79	1.6
75	0.8

Table 3: Pattern of Test Papers

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
1.5 Hrs	One word	4	4	1	4
	Short Answer	4	4	2	8
	Paragraph	3	2	5	10
	Essay	2	1	10	10
				Total Marks*	32

*Marks: 80% and above = 2, 60 to below 80% = 1.5, 50 to below 60% = 1, 35 to below 50% = 0.5, below 35% = 0.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examinations will be conducted at the end of each semester.

Table 1: Pattern of Question Papers

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
3 Hrs	One word	10	10	1	10
	Short Ansrer	10	7	2	14
	Paragraph	6	4	5	20
	Essay	4	2	10	20
				Total Marks*	64

COMPLEMENTARY COURSE PRACTICAL: EVALUATION SCHEME

The evaluation scheme contains two parts: *viz.,* internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks are for internal evaluation. The colleges shall send only the marks obtainedfor internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	Components	Marks
1	Attendance in the lab	4
2	Punctuality, Performance and Discipline	2
3	Model tests I & II	2 + 2
4	Practical Record: Required no.of experiments and neatness	4
5	Viva - Voce	2
	Total Marks	16

Table 2: Percentage of Attendance and Eligible Marks

% of Attendance	Marks
Above 90	4
85 - 89	3.2
80 - 84	2.4
76 - 79	1.6
75	0.8

Table 3: Number of Experiments and Marks for Practical Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis	Mixture Analysis
13 – 14(2)	10(2)
11 – 12(1.5)	8 – 9(1.5)
10(1)	7(1)

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. Practical examination along with Viva-voce will be conducted at the end of 4th semester.

Table 1: Pattern of Question Paper

Duration	Pattern	Marks	Total Marks
3 Hrs	Questions on qualitative and quantitative analysis	6	64
	Procedure for volumetric Analysis	4	
	volumetric Analysis	20	
	Mixture Analysis	24	
	Record	6	
	Viva - Voce	4	

Guidelines

1. *Valuation of Volumetric Procedure*: Eight points – 4 marks. 1. Correct intermediate; 2.Preparation of standard solution; 3. Standardisation of intermediate; 4. Indicator and end point of standardization; 5. Making up of given solution; 6. Titration of made up solution; 7. Indicator; 8. End point/any other relevant points.

2. *Marks for Result:* The reported values (RV) of the students are compared with theoretical value (TV) and skilled value (SV) and calculate error percentage. Up to 1.5% error: 16 marks; between 1.51 – 2%: 10 marks; between 2.1– 2.5%: 7 marks; between 2.51– 3%: 4 marks; greater than 3%: 2 marks.

3. *Marks for Calculation:* Eight points – 4 marks. 1. Equivalent mass of the primary standard substance; 2. Calculation of normality of primary standard; 3. Table for standardization of intermediate with standard substance and indicator at the top; 4. Calculation of normality of the intermediate; 5. Table for estimation including standard substance and indicator; 6. Calculation of normality of the given solution; 7. Equivalent mass of the compound/ion in the given solution; 8. Calculation of weight in the whole of the given solution.

4. *Marks for Mixture Analysis:* Group identification: 1 mark each. Cation identification tests: 3 mark each. Chemistry of identification tests: 2 mark each. Cation confirmation tests: 3 marks each. Chemistry of confirmation tests: 2 mark each. Systematic procedure: 2 marks.

Table 2: Evaluation of Records

Number of Experiments (Marks in brackets)	
Volumetric Analysis Max. Marks: 3	Mixture Analysis Max. Marks: 3
12 – 13(3)	10(3)
11 (2.5)	9(2.5)
10(2)	8(2)
9(1.5)	7(1.5)

QUESTION PAPER PATTERN
FOR
COMPLEMENTARY COURSE

----------SEMESTER B. Sc. DEGREE EXAMINATION

Course Code:----------Complementary Course Name ----------

Time: 3 Hours **Maximum marks: 64**

Section A (One word)

Answer all questions. Each question carries 1 mark

Question numbers 1 - 10: Either fill in the blanks or multiple choice

Section B (Short answer)

Answer any seven questions. Each question carries 2 marks

Question numbers 11 - 20: Answerable in one or few sentences. Definitions/equations/problems with direct application of simple equations/meaning of terms etc

Section C (Paragraph)

Answer any four questions. Each question carries 5 marks

Question numbers 21 - 26: Answerable in one or two Paragraphs. Definitions with illustration/ problems /mechanisms/method of preparations etc

Section D (Essay)

Answer any two questions. Each question carries 10 marks

Question numbers 27 – 30: Essays

Model of Practical Course Question Papers

FOURTH SEMESTER B. Sc. DEGREE EXAMINATION
ACHE4C05P; Complimentary Course V: CHEMISTRY PRACTICAL

Time: 3 Hours **Maximum marks: 64**

Section A

Answer the following questions in 6 minutes.

1. Calculate the mass of Mohr's salt required to prepare 100 mL of its 0.05 N solution?

2. Calculate the normality of oxalic acid solution when 0.63 g of it is dissolved in water in a 100 mL standard flask?

3. Name the indicator used for the titration of Na2CO3 against HCl.
4. The yellow precipitate formed on adding potassium chromate solution to Ba2+ salt solution is chemically ---------

5. What is/are the group reagent/s for 5th group in inorganic qualitative analysis?

6. The chemical compound formed in the ash test for aluminium is ----------

(1x6 = 6 Marks)

Section B

Answer the following question in 10 minutes

7. Give a brief outline of the method for the volumetric estimation of oxalic acid in the whole of thegiven solution, being provided with AR Mohr's salt crystals.

(4 Marks)

Section C

8. Estimate volumetrically the mass of FeSO4.7H2O present in the whole of the given solution, being provided with pure Mohr's salt and approximately 0.1N K2Cr2O7 solution.

(20 Marks)

9. Analyse qualitatively and systematically the given solution with a view to identify and confirm the two cations present in it. Submit a detailed report including chemistry of the identification and confirmation tests & systematic procedure. *(24 Marks)*

Section D

Viva-Voce *(4 marks)*
Record *(6 marks)*

SYLLABUS
FOR
OPEN COURSES

OPEN COURSE STRUCTURE
(FOR STUDENTS OTHER THAN B.Sc. CHEMISTRY)

Total Credits: 2 (Internal 20%; External 80%)

Sem-ester	Code no of course	Course Title	Hrs/ week	Total hrs	Cre-dit	marks
V	**ACHE5D01T**	Open Course 1: Environmental Chemistry	2	36	2	50
	ACHE5D02T	Open Course 2: Chemistry in daily life				
	ACHE5D03T	Open Course 3: Food Science and Medicinal Chemistry				

SEMESTER V
Course Code: ACHE5D01T
Open Course 1: ENVIRONMENTAL CHEMISTRY

Total Hours: 36 **Credits: 2** **Hours/Week: 2**
Note: *Structure and chemical equations not required.*

Module I: Environment (3 hrs)

Concept and scope of environmental chemistry – Segments of environment. Environmental pollution: Concepts and definition – Pollutant, contaminant, receptor and sink – Classification of pollutants - Global, regional, local, persistent and non-persistent pollutants.

Module II: Air Pollution (6 hrs)

Major regions of atmosphere – Tropospheric pollution and stratospheric pollution – Major air pollutants: Oxides of carbon, nitrogen and sulphur- Hydrocarbons – Chlorofluorocarbons - Particulates. Smog: London smog and photochemical smog. Automobile pollution. Effects of air pollution: Acid rain, green house effect and depletion of ozone layer. Control of air pollution - Alternate refrigerants – Bhopal Tragedy (a brief study). Causes, symptoms and drugs used for the treatment of air-borne diseases: Chickenpox, influenza, measles and tuberculosis.

Module III: Water Pollution (9 hrs)

Hydrological cycle – Importance of water - Aquatic pollution – Visible signs of aquatic pollution – Water pollution due to human activity – Pollution due to sewage, domestic wastes, industrial effluents, agricultural discharge, soaps and detergents. Eutrophication. Types of water pollutants: Biological agents, physical agents and chemical agents. Biological magnification and bioaccumulation. Water quality parameters: DO, BOD, COD, alkalianity, hardness, chloride, fluoride and nitrate. Toxic metals in water and their effects: Cadmium, lead and mercury - Minamata disaster (a brief study). Water born diseases: Cholera, dysentery and typhoid – Symptoms and medicines.

Module IV: Soil, Noise, Thermal and Radioactive Pollutions (6 hrs)

Soil pollution: House hold, municipal and industrial solid wastes. Pollution due to plastics, pesticides, biomedical waste and E-waste (source, effects and control measures) – Non-degradable, degradable and biodegradable wastes. Hazardous waste. Noise pollution, thermal pollution and radioactive pollution (source, effects and control measures) – Hiroshima, Nagasaki and Chernobyl accidents (brief study). Endosulfan disaster in Kerala (brief study).

Module V: Pollution Control Measures (12 hrs)

Air pollution control measures – Gravitational settling chamber, fabric filter, wet scrubber, catalytic converters, stacks and chimneys, cyclone collectors, Cottrell electrostatic precipitator, extraction entilator, zoning and green belt. Water treatment methods - Primary, secondary and tertiary methods -

Aerobic and anaerobic oxidation - Sedimentation, coagulation, filtration, disinfection, desalination and ion exchange - USAB process and deep well injection.

Solid waste management: Recycling, incineration, digestion, dumping, land treatment and composting. Introduction to Green chemistry (elementary ideas only).

Pollution Control Board: Duties and responsibilities (a brief study). Some Environmental movements: Chipco, Narmada, Silent Valley and Plachimada.

References

1. A.K. De, *Environmental Chemistry*, 6th Edition, New Age International, New Delhi, 2006.

2. S.S. Dara, *A Textbook of Environmental Chemistry and Pollution Control*, 8th Edition, S. Chand
and Sons, New Delhi, 2008 (Reprint).

3. S.E. Manahan, *Environmental Chemistry*, 8th Edition, CRC Press, Florida, 2004.

4. P.K. Goel, *Water Pollution: Causes, Effects and Control*, New Age International, New Delhi, 2006.
5. Kochu Baby Manjooran, *Modern Engineering Chemistry*, Kannatheri Publications, 2009.

6. A.K. Ahluwalia, *Environmental Chemistry*, Ane Books India, New Delhi, 2008.
7. B.K. Sharma and H. Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1996

SEMESTER V

Course Code: ACHE5D02T

Open Course 2: CHEMISTRY IN DAILY LIFE

Total Hours: 36 **Credits: 2** **Hours/Week: 2**

Note: *Structure and chemical equations not required.*

Module I: Dyes and Pharmaceuticals (6 hrs)

Dyes: Requirements of a dye - Classification based on mode of application to the fabric - Applications of dyes (general study). Ancient and modern colours – Mention of indigo and alizarin.

Pharmaceuticals: Drug: Chemical name, generic name and trade names with examples. Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Antipyretics, analgesics, antacids, antihistamines, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilizers, narcotics, antidepressants and psychedelic drugs (definition and examples).

Module II: Food (6 hrs)

Common Adulterants in Different Foods: Milk and milk products, vegetable oils, cereals, tea, coffee powder, chilly powder and beverages.

Food Additives: Antioxidants and food preservatives – Commonly used permitted and non-permitted food colours - Artificial sweeteners – Taste enhancers - Artificial ripening of fruits and its side effects.

Modern Food Habits: Definition and health effects of fast foods, instant foods, dehydrated foods and junk foods. Harmful effects of modern food habits. Importance of milk, coconut water and Neera.

Module III: Polymers (6 hrs)

Types of polymers – Natural, semi synthetic and synthetic polymers with examples – Thermoplastics and thermosetting plastics. Applications of polythene, polypropene, polystyrene, PAN, PMMA, PVC, teflon, Nylon 66, bakelite, melmac, terylene, kevlar, nomex, lexan and synthetic rubbers – Natural silk and artificial silk – Advantages of vulcanized rubber – Plastic identification codes – Applications of biodegradable polymers (PGA, PLA and PHBV) - Importance of plastic recycling.

Module IV: Fuels (6 hrs)

Definition and classification of fuels – Characteristics of a good fuel – Combustion - Calorific value – Wood.

Coal: Classification based on carbon content – Fractional distillation products of coal and uses of various fractions.

Petroleum: Origin – Fractional distillation – Different fractions, their composition and uses. Petrol: Knocking - Octane number - Aviation fuel. Diesel: Cetane number. Flash point. Natural gas, biogas and LPG: Composition and uses.

Pollution due to burning of fossil fuels.

Solar energy and solar cells (applications only).

Module V: Agriculture (3 hrs)

Fertilizers: Essential nutrients for plants – NPK value - Natural and synthetic fertilizers - Nitrogenous, phosphatic and potash fertilizers (examples) – Impact of excessive use of fertilizers on environment – Bio fertilizers.

Pesticides: Classification - Insecticides, herbicides, rodenticides and fungicides (definition and examples only) – Non-degradable pesticides – Pesticide pollution and its impact on environment – Endosulfan disaster in Kerala (brief study). Pheromones.

Module VI: Cleansing Agents and Cosmetics (6 hrs)

Cleansing Agents: Soaps - Hard and soft soaps - Alkali content – TFM - Detergents (classification) – Cleaning action - Advantages and disadvantages of soaps and detergents - Shaving creams. Shampoos: Ingredients and functions - Different kinds of shampoos (Anti-dandruff, anti-lice, herbal and baby shampoos). Tooth paste: Composition and health effects.

Cosmetics: Hair dye: Chemicals used and its harmful effects. Face and skin powders: Types, ingredients and functions. Cleansing creams: Cold creams, vanishing creams and bleach creams. Perfumes, antiperspirants, Sun screen preparations, nail polishes, lipsticks, rouges, eyebrow pencils and eye liners (ingredients and functions) – Harmful effects of cosmetics.

Module VII: Advanced Materials (3 hrs)

Nanotechnology: Introduction - Potential uses of nanomaterials in computers, sensors in textiles, mobile electronic devices and vehicles - Medical applications of nanomaterials.

Conducting Polymers: Polyacetylene – Applications.

References

1. B.K. Sharma, *Industrial Chemistry*, 11th Edition, Goel publishing House, Meerut, 2000.

2. K.S. Tewari, N.K. Vishnoi and S.N. Mehrotra, *A Textbook of Organic Chemistry*, 2nd Edition, Vikas Publishing House (Pvt.) Ltd., New Delhi, 2004.

3. Gurdeep R. Chatwal, *Synthetic Drugs*, Himalaya Publishing House, Bombay, 1995.

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6. Brian A. Fox, Allan G. Cameron and Edward Arnold, *Food Science, Nutrition and Health*, 6th Edition, Edward Arnold, London, 1995.

7. V.R. Gowarikar, *Polymer Chemistry*, New Age International Pvt. Ltd., New Delhi, 2010.

8. B.K. Sharma, *Polymer Chemistry*, Goel Publishing House, Meerut, 1989.

9. M.G. Arora, M. Singh and M.S. Yadav, *Polymer Chemistry*, 2nd Revised Edition, Anmol Publications Private Ltd., New Delhi, 1989.

10. B.K.B. Rao, *Modern Petroleum Refining Processes*, 4th Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.

11. M.S.R. Winter, *A Consumer's Dictionary of Cosmetic Ingredients*, 7th Edition, Three Rivers Press, New York, 2009.

12. H.S. Rathore and L.M.L. Nollet, *Pesticides: Evaluation of Environmental Pollution*, CRC Press, USA, 2012.

13. V.S. Muralidharan and A. Subramania, *Nano Science and Technology*, Ane Books Pvt. Ltd., Chennai, 2009

SEMESTER V

Course Code: ACHE5D03T

Open Course 3: FOOD SCIENCE AND MEDICINAL CHEMISTRY

Total Hours: 36 **Credits: 2** **Hours/Week: 2**

Note: *Structure and chemical equations not required.*

Module I: Food Adulteration and Preservation (6 hrs)

Common Adulterants in Different Foods and their Identification: Milk and milk products, vegetable oils and fats, spices and condiments, cereals, pulses, tea, coffee powder, chilly powder, turmeric powder and beverages - Contamination with toxic chemicals, pesticides and insecticides.

Methods of Preservation: Need for preservation - Classification - Freezing, smoking, use of sugar, pickling, artificial food additives, canning and bottling, high pressure, burial in the ground, controlled use of micro organism and bio-preservation.

Packaging of Foods: Classification - Materials used for packaging – Harmful effects.

Module II: Chemistry of Food (9 hrs)

Food Additives: Antioxidants and food preservatives – Commonly used permitted and non-permitted food colours - Artificial sweeteners - Taste enhancers – Monosodium glutamate – Vinegar – Artificia ripening of fruits and its health effects.

Modern Food Habits: Introduction – Definition and health effects of fast foods, instant foods, dehydrated foods, junk foods and condiments - Composition and health effects of chocolates, soft drinks and soda water - Classification of alcoholic beverages - Addiction to alcohol - Cirrhosis of liver and social problems. Harmful effects of modern food habits.

Natural Food: Importance of milk, coconut water and Neera - Importance of regional and seasonal fruits – Traditional Kerala foods and their advantages.

Module III: Medicinal Chemistry – I (9 hrs)

Health and Biochemical Analysis: Definition of health - WHO standard - Biochemical analysis of urine and serum. Blood: Composition, grouping and Rh factor - Blood transfusion.

First Aid and Safety: Electric shocks, hemorrhage, cuts, wounds, burns and snake bite.

Biochemistry: Vitamins (name, source, function and deficiency diseases). Enzymes (classification, characteristics, function and examples) - Hormones (classification, organ of secretion and functions) - Nucleic acids (introduction and role in life processes) – DNA finger printing (a brief study). *Indian Medicinal Plants:* Kizharnelli, Thumbai, Hibiscus, Adathodai, Nochi, Thulasi, Brahmi, Aloe Vera and Neem plant (major chemical constituents and medicinal uses).

Essential Oils: Extraction by steam distillation – Source and medicinal uses of eucalyptus oil, sandalwood oil and lemongrass oil.

Module IV: Medicinal Chemistry – II (12 hrs)

Medicines: Drug - Chemical name, generic name and trade names with examples – Terminology: Prodrug, pharmacy, pharmacology, pharmacophore, pharmacognosy, pharmacodynamics and pharmacokinetics (elementary idea only). Routes of drug administration: Topical, enteral and parenteral. Definition and examples of antacids, antipyretics, analgesics, antibiotics, antiseptics,

disinfectants, antihistamines, tranquilizers, narcotics, antidepressants and hallucinogenic drugs – Drug toxicity – Thalidomide tragedy (a brief study) - Effective use of drugs – Prescription and non-prescription drugs – Over dosage – Drug abuse.

Some Diseases and Treatment: Causes, symptoms and drugs used for the treatment of influenza, measles, tuberculosis, cholera, dysentery, bronchial asthma, kidney stone, diabetes and myocardial infarction – Drugs used in the treatment for systemic hypertension and hypercholesterolemia. Cancer: Definition - Lung cancer (causes, symptoms and treatment) – Avenues for the treatment of terminal cancer. Medical applications of nanomaterials. Radio diagnosis: Benefits and risks. Biodegradable polymers used in surgical sutures and capsule covers.

References

1. B. Srilakshmi, *Food Science*, 5th Edition, New Age Publishers, New Delhi, 2010.

2. B. Siva Sankar, *Food Processing and Preservation,* Prentice–Hall of India Pvt. Ltd., New Delhi, 2002.

3. Lillian Hoagland Meyer, *Food Chemistry*, 1st Edition, CBS Publishers & Distributors, New Delhi, 2004.

4. Brian A. Fox, Allan G. Cameron and Edward Arnold, *Food Science, Nutrition and Health*, 6th Edition, Edward Arnold, London, 1995.

5. Guyton and Hall, *Textbook of Medical Physiology*, 12th Edition, Saunders, US, 2010.

6. B.L. Oser, *Hawk's Physiological Chemistry*, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1979.

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9. S.C Rastogi, *Biochemistry*, 2nd Edition, Tata McGraw Hill Publishing Co., New Delhi, 200 (Reprint).

10. Rasheeduz Zafar, *Medicinal Plants of India*, 1st Edition, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2009.

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SCHEME OF EVALUATION
FOR
OPEN COURSES

OPEN COURSE: EVALUATION SCHEME

The evaluation scheme contains two parts: *viz.,* internal evaluation and external evaluation.

1. INTERNAL EVALUATION

20% of the total marks are for internal evaluation. The colleges shall send only the marks obtained for internal examination to the university.

Table 1: Components of Evaluation

Sl. No.	Components	Marks
1	Attendance	2.5
2	Tests Papers I & II	2.5 + 2.5
3	Assignment/ Viva - Voce	2.5
Total Marks		10

Table 2: Percentage of Attendance and Eligible Marks

% of Attendance	Marks
Above 90	2.5
85 - 89	2
80 - 84	1.5
76 - 79	1
75	0.5

Table 3: Pattern of Test Papers

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
1 Hr	One word	3	3	1	3
	Short Ansrer	1	1	2	2
	Paragraph	2	1	5	5
	Essay	2	1	10	10
Total Marks*					20

*Marks: 80% and above = 2.5, 60 to below 80% = 2, 50 to below 60% = 1.5, 40 to below 50% = 1, 35 to below 40% = 0.5, below 35% = 0.

2. EXTERNAL EVALUATION

External evaluation carries 80% marks. University examination will be conducted at the end of 5th semester.

Table 1: Pattern of Question Paper

Duration	Pattern	Total no. of questions	No. of Questions to be answered	Marks for each questions	Marks
2Hrs	One word	10	10	**1**	10
	Short Ansrer	7	5	**2**	10
	Paragraph	3	2	**5**	10
	Essay	2	1	**10**	10
				Total Marks	40

MODEL QUESTION PAPERS
FOR
OPEN COURSES

Question Papers of all Open courses should have the following model

FIFTH SEMESTER B. Sc. DEGREE EXAMINATION
(UG-CBCSS) Chemistry

ACHE5D01T; Open Course ?: ---------- CHEMISTRY

Time: 2 Hours **Maximum marks: 40**

Section A (One word)
Answer all questions. Each question carries 1 mark

Question numbers 1 - 10: Either fill in the blanks or multiple choice

Section B (Short answer)
Answer any five questions. Each question carries 2 marks

Question numbers 11 - 17: Answerable in one or few sentences. Definitions/equations/problems with direct application of simple equations/meaning of terms etc

Section C (Paragraph)
Answer any two questions. Each question carries 5 marks

Question numbers 18 - 20: Answerable in one or two Paragraphs. Definitions with illustration/ problems /mechanisms/method of preparations etc

Section D (Essay)
Answer any one question. Each question carries 10 marks

Question numbers 21 and 22: Essays